Bulletin of
Duke University

The Pratt School of Engineering
Professional Master's Programs
2025-2026

About the University Bulletins

The Office of the University Registrar is responsible for compiling, producing, and maintaining the bulletin for each school at Duke University. The content for the bulletins is established by the schools in conjunction with the Duke University Bulletins Policy.

The information in this bulletin applies to the academic year 2025-2026 and is accurate and current, to the greatest extent possible, as of August 2025. All bulletins are published online and serve as static documents for historical records of the university. The university reserves the right to change programs of study, academic requirements, teaching staff, the calendar, and other matters described herein without prior notice, in accordance with established procedures.

Duke University Registrar: Frank Blalark, Assistant Vice Provost and University Registrar

Coordinating Editor: Maggie Douglas

Publications Coordinator: Patrina W. Hemingway

Bulletin School Coordinators:

- Divinity School: Deborah Hackney, Katherine Smith, and Jessica Williams
- Fuqua School of Business: B. Tate
- The Graduate School: Scott Behm and Matthew Jones
- School of Law: Frances Curran and Monica Roberson
- School of Medicine: Marcie Ellis and Cierra Harris
- Nicholas School of the Environment: Cynthia Peters
- School of Nursing: Debra Mattice and Bebe Mills
- Pratt School of Engineering Professional Programs: Cherie Creten
- Sanford School of Public Policy: Anita Lyon
- Undergraduate Instruction: Claire Siburt

Photograph Credits: Sarah Belles, Ken Huth, Huthphoto, Shaun King, Jared Lazarus, Megan Mendenhall, Alex Mousan, Mary Katherine Powers, Ivy Shi, Bill Snead, Les Todd, and John West

Duke University
2080 Duke University Road
Durham, NC 27708
(919) 684-8111

This publication is available in alternative format on request. Call (919) 684-2813.

Duke University's Mission & History

Mission Statement

Approved by the Duke University Board of Trustees October 1, 1994, and revised February 23, 2001, the Mission Statement for Duke University reads as follows:

"James B. Duke's founding Indenture of Duke University directed the members of the University to 'provide real leadership in the educational world' by choosing individuals of 'outstanding character, ability, and vision' to serve as its officers, trustees and faculty; by carefully selecting students of 'character, determination and application;' and by pursuing those areas of teaching and scholarship that would 'most help to develop our resources, increase our wisdom, and promote human happiness.'

"To these ends, the mission of Duke University is to provide a superior liberal education to undergraduate students, attending not only to their intellectual growth but also to their development as adults committed to high ethical standards and full participation as leaders in their communities; to prepare future members of the learned professions for lives of skilled and ethical service by providing excellent graduate and professional education; to advance the frontiers of knowledge and contribute boldly to the international community of scholarship; to promote an intellectual environment built on a commitment to free and open inquiry; to help those who suffer, cure disease, and promote health, through sophisticated medical research and thoughtful patient care; to provide wide-ranging educational opportunities, on and beyond our campuses, for traditional students, active professionals and life-long learners using the power of information technologies; and to promote a deep appreciation for the range of human difference and potential, a sense of the obligations and rewards of citizenship, and a commitment to learning, freedom and truth.

"By pursuing these objectives with vision and integrity, Duke University seeks to engage the mind, elevate the spirit, and stimulate the best effort of all who are associated with the University; to contribute in diverse ways to the local community, the state, the nation and the world; and to attain and maintain a place of real leadership in all that we do."

Duke University: A Brief Narrative History

Duke University traces its origins to a small school that opened in 1838 in Randolph County, North Carolina. Originally a preparatory school for young men called the Union Institute Academy, it was then chartered as a teaching college named Normal College by the state of North Carolina in 1851. The school underwent another transformation in 1859 when it turned to the Methodist Church for financial support. Reflecting the new partnership, the school's name changed to Trinity College.

From 1842 to 1882, Braxton Craven served as the principal and then president of the institution, overseeing its transition from a tiny schoolhouse to a full-fledged college. Shortly before his death, he helped to establish the Cherokee Industrial School at Trinity College, one of numerous schools established in the United States to "westernize" indigenous students, in this case boys and young men from the Eastern Band of the Cherokee. The School at Trinity lasted only a few years. It is worth noting that Craven enslaved several Black people prior to the Civil War, and that a number of other faculty and trustees were also enslavers.

John F. Crowell, Trinity College's president from 1887-1894, suggested that moving the college to an urban setting would attract more students, faculty, and financial support. With Crowell's encouragement, the trustees agreed to move the college, and after a spirited competition among regional cities, Trinity opened in Durham in 1892. Local tobacco magnates Washington Duke and Julian S. Carr assisted in providing land and money to Trinity. In 1897, at Washington Duke's request, the school began admitting women as regular students, making it an early co-educational institution. Carr's support for Trinity College was recognized with a building named in his honor in 1930. His name was removed in 2018 in light of his virulent white supremacist beliefs and actions.

Trinity prospered in its new location, and in 1924 the school was again transformed through philanthropy. Washington Duke's son James Buchanan Duke established the Duke Endowment, and the charitable foundation infused the college with funds. The trustees changed Trinity College's name to Duke University as a memorial to his father. The new funds supported the construction of a new campus, designed in a Gothic style by the Philadelphia architectural firm of Horace Trumbauer. The chief designer of West Campus, as well as the re-envisioned East Campus, was Julian Abele, a Black architect whose role in creating the architecture of Duke University was largely overlooked during his lifetime. In 2016, the main quad on West Campus was renamed Abele Quad in his honor.

President William P. Few (1910-1940) oversaw this metamorphosis of a small college into a complex university. In 1930, the Trinity College site (today's East Campus) became the Woman's College, while the West Campus served as the grounds for the all-male Trinity College. In 1972, Trinity College merged both colleges of men and women into what is now known as Trinity College of Arts and Sciences. Other schools include the School of Religion and Graduate School founded in 1926, the School of Medicine and hospital in 1930, and the School of Nursing in 1931. Originally established in 1904, the Law School reorganized in 1930. In 1938, what is today's Nicholas School of the Environment opened, and in 1939 the university formed what is now known as the Pratt School of Engineering. The last of James B. Duke's desires for the university was fulfilled when what is now the Fuqua School of Business, opened in 1969. The Sanford School of Public Policy became Duke's tenth school in 2005. The school was named for President Terry Sanford, formerly the governor of North Carolina, who supported a number of initiatives in the 1970s and 1980s to build Duke's reputation for excellence, growing the university's national and international profile.

Long a segregated institution, Duke first admitted Black graduate and professional students in 1961 and Black undergraduates in 1963. In 1968, a major student protest known as the Vigil demanded pay increases and better treatment of hourly workers, most of whom were Black. In 1969, Black students protested in what is now known as the Allen Building Takeover, demanding improved services and treatment for Black students. The protest resulted in the formation of what is now called the Department of African and African American Studies.

Faculty at Duke produce influential scholarship across a wide range of disciplines and professions. Two Duke faculty members have received the Nobel Prize in Chemistry: Professor Robert Lefkowitz in 2012 and Professor Paul Modrich in 2015. Duke researchers have mapped the human chromosome and led research into the treatment of HIV and AIDS. Duke faculty also research pressing social issues, producing high-impact scholarship on such topics as election districting and public health. Faculty authors have written books of award-winning nonfiction, fiction, and poetry, and have won awards ranging from the National Book Award to the Pulitzer Prize. Fifty Duke faculty are members of the American Academy of Arts and Sciences. Duke students have many opportunities to work with leading faculty in labs and on projects, ensuring hands-on experience during their course of study.

Duke has a number of notable athletic achievements. Best known is the men's basketball team, coached by Mike Krzyzewski from 1980 to 2022. The team has earned 5 national championships. The women's golf team holds the record at Duke for most national championships, at 7. Duke football has been played since the 1880s, when President Crowell coached the team himself. During the 1930s and 1940s, the football team competed in and won a number of bowl games, earning the nickname "Iron Dukes." The Rose Bowl game of 1942 was played in Durham due to wartime concerns on the West Coast and remains the only Rose Bowl played outside of Pasadena, California.

International programs have expanded over the last several decades, bringing international students to Duke in Durham and expanding international opportunities for Duke students. In 2005, Duke partnered with the National University of Singapore and opened the Duke-NUS Medical School. In 2014, graduate programs at Duke Kunshan University began, followed by undergraduate programs in 2018. DKU is a partnership between Duke and Wuhan University in Kunshan, China.

The university has changed in many ways since its founding, and like other historically white schools it continues to confront issues of racism, sexism, and other inclusion and equity challenges. Students of color and international students now represent more than 50% of the student body. Duke's hometown of Durham has also grown and changed, and Duke and Durham collaborate on topics ranging from community service to downtown development.

Ever evolving, Duke University strives to meet the stated aims of the university: “to foster a lively relationship between knowledge and faith; to advance learning in all lines of truth; to defend scholarship against all false notions and ideals; to develop a love of freedom and truth; to promote a respectful spirit of dialogue and understanding; to discourage all partisan and sectarian strife; and to further the advancement of knowledge in service to society.”

Updated September 21, 2020. Learn more from University Archives.

Duke University Leadership & Faculty

Full leadership profiles for those listed below are available at duke.edu/about/leadership.

Executive Leadership

Vincent E. Price, President
Craig Albanese, CEO, Duke University Health System
Daniel Ennis, Executive Vice President
Alec Gallimore, Provost
Mary E. Klotman, Executive Vice President for Health Affairs, Duke University

Academic Leadership

Deans of Schools and Colleges

Kerry Abrams, James B. Duke and Benjamin N. Duke Dean of the School of Law
Suzanne Barbour, Dean, Graduate School
Lori Bennear, Stanback Dean, Nicholas School of the Environment
Gary Bennett, Dean, Trinity College of Arts and Sciences
Edgardo Colón-Emeric, Dean, Divinity School
Mary E. Klotman, Dean, School of Medicine
Jerome P. Lynch, Dean, Pratt School of Engineering
Mary Frances Luce, Interim Dean, Fuqua School of Business
Manoj Mohanan, Interim Dean, Sanford School of Public Policy
Micheal Relf, Dean, School of Nursing

Vice Provosts

Lee Baker, Vice Provost for Undergraduate Education (effective October 1)
Edward Balleisen, Vice Provost for Interdisciplinary Studies
Abbas Benmamoun, Vice Provost for Faculty Advancement
David Bowersox, Vice Provost for Finance & Administration
Mary Pat McMahon, Vice Provost/Vice President of Student Affairs
Mohamed Noor, Executive Vice Provost
Noah Pickus, Associate Provost
Deborah F. Rutter, Vice Provost for the Arts
Joseph Salem, Rita DiGiallonardo Holloway University Librarian and Vice Provost for Library Affairs, & Interim Vice Provost for Learning Innovation & Lifetime Education and Digital Education
Toddi Steelman, Vice President and Vice Provost for Climate and Sustainability

University Administration

Maggie Epps, Secretary to the Board of Trustees and Chief of Staff to the President
Tracy Futhey, Vice President for Information Technology and Chief Information Officer
Leigh P. Goller, Chief Audit, Risk and Compliance Officer
Kimberly Hewitt, Vice President for Institutional Equity and Chief Diversity Officer
David L. Kennedy, Vice President for Alumni Engagement and Development
Nina E. King, Vice President and Director of Athletics
Jennifer Lodge, Vice President for Research & Innovation
Antwan Lofton, Vice President of Human Resources & Chief Human Resources Officer
John J. Noonan, Vice President for Facilities
Rachel L. Satterfield, Vice President for Finance and Treasurer
Chris Simmons, Vice President for Government Relations
Kim Taylor, Vice President and General Counsel
Frank Tramble, Vice President for Communications, Marketing and Public Affairs
Neal Triplett, President, DUMAC
Stelfanie Williams, Vice President for Community Affairs

The Faculty

Duke faculty are chosen from among the most competitive selection processes in the country, having demonstrated excellence in their fields of research. Profiles of Duke's faculty members are available via Scholars@Duke.

Duke University Policies

Accreditation

Duke University is accredited by the Southern Association of Colleges and Schools Commission on Colleges (SACSCOC) to award baccalaureate, masters, doctorate, and professional degrees. Contact SACSCOC at sacscoc.org or call (404) 679-4500 for questions about the accreditation of Duke University.

Clery Act

Information that the university is required to make available under the federal Clery Act is available by visiting the Records Division, Duke University Police Department, 502 Oregon Street, Durham, NC 27708, or by calling (919) 684-4602. See police.duke.edu/news-stats/clery for more details.

Duke's Commitment to Inclusive Excellence

Duke aspires to create a community built on collaboration, innovation, creativity, and belonging. Our collective success depends on the robust exchange of ideas—an exchange that is best when the rich diversity of our perspectives, backgrounds, and experiences flourishes. To achieve this exchange, it is essential that all members of the community feel secure and welcome, that the contributions of all individuals are respected, and that all voices are heard. All members of our community have a responsibility to uphold these values.

Find more details at provost.duke.edu/about.

Duke Community Standard

Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and nonacademic endeavors, and to protect and promote a culture of integrity.

To uphold the Duke Community Standard:

- I will not lie, cheat, or steal in my academic endeavors;
- I will conduct myself honorably in all my endeavors; and
- I will act if the Standard is compromised.

Students' Obligation to Act with Respect to the Duke Community Standard

The Duke Community Standard (DCS) stresses the commitment that students share with all members of the community to enhance the climate for honesty, fairness, respect, and accountability at Duke University. Students affirm their commitment to foster this climate by signing a pledge that includes taking constructive action if they witness or know about behavior they perceive to be inconsistent with the DCS, which may include violation of university policies. Although there are no disciplinary sanctions associated with the failure to act, students are nonetheless expected to take action to do something as a responsibility of membership in the Duke community.

The university recognizes that it is not always easy to act in these situations, but several alternatives are available to suit a student's level of comfort and confidence. These alternatives are not mutually exclusive.

- Speaking directly with the individual exhibiting the behavior, both to gain clarity about the situation and to inform the individual about the concern.
- Publicly calling attention to the behavior as it is occurring.
- For incidents involving social behaviors, alerting residence hall, Student Affairs, or other university staff. The information provided will give staff an opportunity to address the matter informally or through appropriate formal channels.
- For cases involving academic integrity, alerting the instructor that cheating may be occurring in the course. This alert can be in any form, including anonymous notification, and the reporting student will not be identified. The information provided will allow the faculty member to consider corrective measures, in consultation with the Office of Student Conduct and Community Standards, and to address the topic with the class or suspected student(s).
- Directly alerting staff in the Office of Student Conduct and Community Standards at (919) 684-6938 or conduct@duke.edu, who will confer with the faculty member involved, if an academic issue, or with the reporting student(s), strategizing next steps. Maintaining the confidentiality of the source is possible, but may limit the extent of action that can be taken.

For current regulations, refer to dukecommunitystandard.students.duke.edu.

Family Educational Rights & Privacy Act (FERPA)

The Family Educational Rights & Privacy Act (FERPA), 20 U.S.C § 1232g; 34 CFR Part 99, is a federal law that guides the release of students' education records, of which disciplinary records are a part.

Duke University adheres to a policy of compliance with the Family Educational Rights and Privacy Act. The policy (1) permits students to inspect their education records, (2) limits disclosure to others of personally identifiable information from education records without students' prior written consent, and (3) provides students the opportunity to seek correction of their education records where appropriate.

For additional information about FERPA, see studentprivacy.ed.gov/ferpa. For Duke's full FERPA policy, visit registrar.duke.edu/student-resources/family-educational-rights-and-privacy-act-ferpa.

Nondiscrimination Statement

Duke is committed to encouraging and sustaining a learning and work community that is free from prohibited discrimination and harassment. Duke does not discriminate on the basis of age, color, disability, ethnicity, gender, gender identity, gender expression, genetic information, national origin, race, religion, sex (including pregnancy and pregnancy-related conditions), sexual orientation, or military status, in the administration of its educational policies, admission policies, financial aid, employment, or any other institution program or activity.

Duke has designated the Vice President for Institutional Equity and Chief Diversity Officer as the individual responsible for the coordination and administration of its nondiscrimination and harassment policies.

Questions or comments about harassment or discrimination can be directed to one of the following administrators in the Office for Institutional Equity.

Discrimination in Duke's programs and activities:

Cynthia Clinton, AVP Harassment and Discrimination Prevention and Compliance
Title IX Coordinator
Office for Institutional Equity
114 S. Buchanan Blvd., Bay 8
Durham, NC 27708
(919) 684-8222

Sex discrimination in educational programs or activities:

Adrienne Allison, Deputy Title IX Coordinator for Students, Compliance Investigator
Office for Institutional Equity
114 S. Buchanan Blvd., Bay 8
Durham, NC 27708
(919) 684-8222

The complete text of Duke's Policy on Prohibited Discrimination, Harassment, and Related Misconduct and appropriate complaint procedures, may be found by visiting the Office for Institutional Equity's website. Additional information and resources are available through the U.S. Department of Education Office for Civil Rights, or call 1-800-421-3481.

Duke University Resources

Academic Resources

Duke University Libraries

The Duke University Libraries are the shared center of the university's intellectual life. The William R. Perkins Library, Bostock Library, and Rubenstein Rare Book & Manuscript Library comprise the main West Campus library complex, which is joined by Lilly and Music libraries on East Campus and the separately administered libraries serving the schools of Business, Divinity, Law, and Medicine. Together they form one of the nation's top ten private university library systems.

Institutes, Initiatives & Centers

The university institutes, initiatives and centers complement the widespread interdisciplinarity found in every school at Duke. They serve as crucial incubators of innovations in research, teaching and community engagement. Find a complete list of institutes, initiatives, and centers at interdisciplinary.duke.edu/university-institutes-initiatives-centers.

Interinstitutional Agreement with Neighboring Universities

Under a plan of cooperation—the interinstitutional agreement among Duke University and The University of North Carolina at Chapel Hill, North Carolina State University, North Carolina Central University, The University of North Carolina at Charlotte, and The University of North Carolina at Greensboro—a student regularly enrolled in Duke University as a degree-seeking student and paying full fees may enroll for one approved course each semester at one of the institutions in the cooperative program unless an equivalent course is offered at Duke in the same academic term. Credit so earned is not defined as transfer credit since grades in courses taken under the interinstitutional agreement are entered on the official record and used in determining the grade point average. Additional information is available at registrar.duke.edu/registration/interinstitutional-registration.

Technology Resources

- The Office of Information Technology (oit.duke.edu)
- Computing and Networking (wireless.duke.edu)

- Printing and Labs (oit.duke.edu/services-tools/printers-labs)
- Support and Training (oit.duke.edu/services-tools/support-training)

Continuing Studies Programs

Duke University offers a variety of pre- and post-college learning opportunities for learners across a wide variety of ages, backgrounds, and geographies. Overseen by Duke Learning Innovation & Lifetime Education (LILE), Duke's continuing students programs provide many opportunities for academic achievement, professional development and personal enrichment. Information about all programs listed below is available at learnmore.duke.edu.

For-Credit Academic Study

Admission to the Continuing Studies Program is discretionary. For consideration for admission, applicants to the Continuing Studies Program must meet at least one of the following two criteria:

- Earned a bachelor's degree from a college or university accredited by a national or regional accrediting body recognized by the Department of Education.
- Age 25 or older, and intend to initiate or complete academic study in a Duke University academic program.

Students are given academic counseling by LILE, and are subject to the regulations set forth for degree candidates, unless explicitly noted otherwise. A junior or senior who is currently enrolled at an external college or university who wishes to pursue an academic discipline unique to Duke University, may apply at learnmore.duke.edu/academics/undergraduate for admission as a nondegree, full-time visiting student for one or two semesters. Students with unique circumstances should contact LILE at learnmore@duke.edu.

Minimum GPA Requirement. Successful applicants are expected to have earned a minimum 3.0 GPA in their most recent program.

Applicants who fail to meet the minimum GPA requirement are subject to additional review and may be admitted on a provisional basis. As part of the additional review, the following will be taken under consideration:

- The applicant has not been enrolled as a full-time student in the last 4 years, and
- The applicant demonstrates the ability to successfully complete college level coursework by earning a passing grade (B or better) in a minimum of 4 courses during the last 2 years.

As part of a provisional admission, a student must earn a minimum 3.0 GPA in the semester immediately following the provisional admission.

Withdrawal. If a student enrolled in a Duke University program withdraws from the program, or is no longer in good academic standing, they must wait two academic terms before re-applying to any Duke program, including any continuing studies programs (see the Satisfactory Continuation Requirements outlined in the Bulletin of Undergraduate Instruction).

Semester Continuation Requirements. Semester continuation requires that you earn a passing grade (C-or better) in a minimum number of courses to remain in good standing. Students who receive at least one failing grade (D, D-, F) are subject to academic probation or academic dismissal.

Academic Probation	Earned D or D-in at least one course Earned F in one course, and C-or better in at least two courses
Academic Dismissal	Earned F in at least one course

Students placed on academic probation must acknowledge their probationary status in writing to the academic dean for Continuing Studies students, in order to continue into the next academic term. They are also expected to seek assistance from campus resources and have their course selection approved by their academic dean. In the probationary term they must earn grades of C or better in all courses to continue. Students who withdraw from all courses must wait two semesters to submit a request to return to study.

Program and application information is available at learnmore.duke.edu/academics/undergraduate. Application deadlines: August 1 for the fall semester, December 1 for the spring semester, April 15 for Term 1 of the summer session, and June 1 for Term 2 of the summer session.

Certificate Programs

Professional Certificates are designed with the needs of working adults in mind, with classes offered in the evening and on weekends. Current programs offered include business and finance, human resources, legal, management, Six Sigma, technology solutions , and more.

Nonprofit Management Program

Learners interested in the nonprofit sector or in community development are invited to explore the noncredit course offerings of this program. Taught by experts and practitioners, these short courses offer instruction concerning financial and resource management, management of personnel and volunteers, leadership development, fundraising, planning and evaluation, board development/governance, and media relations.

Osher Lifelong Learning Institute (OLLI) at Duke

OLLI at Duke began in 1977 as the Duke Institute for Learning in Retirement. Since 2004 the membership organization has been a member of the Osher Lifelong Learning Network, a group of more than 120 institutes across the country dedicated to meeting the needs of older learners and extending the demographic served by traditional universities. OLLI sponsors noncredit course offerings in the fall, winter, and spring as well as special interest groups and volunteer opportunities.

Pre-College

Duke Pre-College programs offer academic enrichment opportunities for academically-motivated middle and high school students in the summer. Current offerings include residential summer camps on Duke's campus and at the Duke Marine Lab, online courses, a coding camp, and community days for local students to experience learning at Duke.

Student Disability Access Office (SDAO)

The Student Disability Access Office (SDAO) is the office on campus that has been charged with and is committed to providing educational opportunities for students with disabilities in compliance with Section 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act of 1990 (ADA), and the ADA Amendments Act of 2008.

Core Functions of SDAO

- To establish services for equitable access on campus through partnership with students with disabilities.
- To manage, coordinate, implement and evaluate accommodation and service programs.
- To serve as a resource to students, faculty, and staff regarding access to academic and campus services
- To provide resource and referral information to the campus community at Duke and prospective students and their families.

SDAO works with each student individually to establish academic accommodations including adjustments, auxiliary aids and services for the purpose of mitigating barriers to students' access to campus facilities, programs, and activities.

For more information, visit access.duke.edu/students.

Duke University Campus Life, Activities & Support

Duke offers a wide variety of resources to help students connect and thrive beyond the classroom.

Dining, Housing & Transportation

- Duke Dining (students.duke.edu/living/dining)
- DukeCard (dukecard.duke.edu)
- Undergraduate Housing (studentaffairs.duke.edu/hdrl)
- Graduate and Professional Student Apartments (students.duke.edu/living/housing/graduate-professional-housing)
- Off-Campus Housing (students.duke.edu/living/housing/graduate-professional-housing/housing-in-durham)
- Parking & Transportation (parking.duke.edu)

Student Affairs & Organizations

- Career Center (careerhub.students.duke.edu)
- Division of Student Affairs (studentaffairs.duke.edu)
- Graduate and Professional Student Government (gpsg.duke.edu)
- Intercollegiate Athletics (goduke.com)
- Religious Life (chapel.duke.edu/religiouslife)

Student Health & Safety

- Campus Police (police.duke.edu)
- Counseling & Psychological Services (CAPS) (studentaffairs.duke.edu/caps)
- DukeReach (students.duke.edu/wellness/dukereach)
- DuWell (studentaffairs.duke.edu/duwell)
- Student Health (studentaffairs.duke.edu/studenthealth)

Mission & History

The Mission of the Pratt School of Engineering

The mission of Duke's Pratt School of Engineering is to provide a rigorous engineering education for both undergraduate and graduate students, enabling them to lead productive, rewarding, and ethical lives for the betterment of society.

The History of the Pratt School of Engineering

Duke's Pratt School of Engineering is a vibrant teaching and research institution focused on education and exploring the frontiers of engineering in a hands-on, cross-disciplinary learning environment. A Duke engineering education is built on a foundation of partnership and shared commitment between students and faculty. Pratt students become successful leaders and compete with the very best students in the world for prestigious scholarships and fellowships.

The mission of the Pratt School of Engineering is to provide a rigorous engineering education for students, enabling them to lead productive, rewarding, and ethical lives for the betterment of society. It is Pratt's vision that engineering students and faculty will be catalysts for generating and integrating knowledge across the disciplines required to address complex issues facing a global society.

The school offers bachelor, master of science, and doctoral degrees majoring in biomedical engineering, civil and environmental engineering, electrical and computer engineering, mechanical engineering, and materials science. The school also offers a professional master of engineering management degree and a suite of master of engineering degrees for students who want to pursue applied engineering roles in industry.

The Pratt School of Engineering and Trinity College of Arts & Sciences are the undergraduate schools of Duke University. The Pratt School of Engineering is also one of Duke's nine graduate and professional schools and has extensive collaboration with the School of Medicine, the Sanford School of Public Policy, Nicholas School of the Environment, School of Law, The Fuqua School of Business, and The Graduate School.

The Pratt School of Engineering is located near North Carolina's famed Research Triangle Park, named for the Triangle formed by Duke University in Durham, The University of North Carolina at Chapel Hill, and North Carolina State University in Raleigh. The 7,000-acre Research Triangle Park, recognized internationally as a center for cutting-edge research and development, is home to more than 200 organizations and more than 100,000 employees.

Academic Calendar

Summer 2025

- February 17 (M) Registration begins for all summer sessions
- May 14 (W) Summer Term 1 classes begin
- May 16 (F) Drop/Add for Term 1 ends (11:59 PM)
- May 26 (M) Memorial Day holiday. No classes are held
- June 19 (Th) Juneteenth holiday. No classes are held
- June 23 (M) Term 1 classes end
- June 24 (T) Reading period (until 7:00 PM); Term 1 final examinations begin (7:00 PM)
- June 26 (Th) Term 1 final examinations end
- June 30 (M) Summer Term 2 classes begin
- July 2 (W) Drop/Add for Term 2 ends (11:59 PM)
- July 4 (F) Independence Day holiday. No classes are held
- August 8 (F) Term 2 classes end
- August 9 (Sa) Reading period (until 7:00 PM); Term 2 final examinations begin (7:00 PM)
- August 11 (M) Term 2 final examinations end (10:00 PM)

Fall 2025

- August 19 (T) New graduate student orientation begins
- August 24 (Su) First-Year Convocation
- August 25 (M) Fall semester classes begin (8:30 AM); Drop/Add continues
- September 1 (M) Labor Day. No classes are held
- September 5 (F) Drop/Add ends (11:59 PM)
- September 25-28 (Th-Su) Founders' Weekend. Classes are held Thursday and Friday
- October 10 (F) Fall break begins (7:00 PM)
- October 15 (W) Classes resume (8:30 AM)
- October 20 (M) Shopping carts open for Spring 2026
- October 29 (W) Registration begins for Spring 2026
- November 25 (T) Thanksgiving recess begins (10:30 PM); Graduate classes end
- November 26-December 9 (W-T) Graduate reading period
- December 10 (W) Final examinations begin (9:00 AM)
- December 15 (M) Final examinations end (10:00 PM)

Spring 2026

- January 7 (W) Spring semester begins (8:30 AM). A Monday class schedule is followed. Drop/Add continues
- January 19 (M) Martin Luther King Jr. Day holiday. No classes are held
- January 21 (W) Drop/Add ends (11:59 PM)
- February 9 (M) Shopping Carts open for Summer 2026
- February 16 (M) Registration begins for Summer 2026
- March 6 (F) Spring recess begins (7:00 PM)
- March 16 (M) Classes resume (8:30 AM)
- March 23 (M) Shopping Carts open for Fall 2026
- April 1 (W) Registration begins for Fall 2026; Summer registration continues

- April 15 (W) Graduate classes end
- April 16-26 (Th-Su) Graduate reading period
- April 27 (M) Final examinations begin
- May 2 (Sa) Final examinations end (10:00 PM)
- May 8 (F) Commencement begins
- May 10 (Su) Graduation exercises; Conferring of degrees

Summer 2026

- May 13 (W) Summer Term 1 classes begin
- May 15 (F) Drop/Add for Term 1 ends (11:59 PM)
- May 25 (M) Memorial Day holiday. No classes are held
- June 19 (F) Juneteenth holiday. No classes are held
- June 22 (M) Term 1 classes end
- June 23 (T) Reading period (until 7:00 PM); Term 1 final examinations begin (7:00 PM)
- June 25 (Th) Term 1 final examinations end
- June 29 (M) Summer Term 2 classes begin
- July 1 (W) Drop/Add for Term 2 ends (11:59 PM)
- July 3 (F) Independence Day holiday. No classes are held
- August 7 (F) Term 2 classes end
- August 8 (Sa) Reading period (until 7:00 PM); Term 2 final examinations begin (7:00 PM)
- August 10 (M) Term 2 final examinations end (10:00 PM)

Administration

Pratt Administration

Jerome Lynch, PhD, F.EMI, Dean

Volker Blum, Dr. rer. nat., Associate Dean for Research

Judge Carr, Senior Associate Dean for Development and Alumni Affairs

Joel Collier, PhD, Associate Dean for Doctoral Education

Rebecca Dupre, Associate Dean for Finance and Administration

Aaron Franklin, PhD, Associate Dean for Faculty Affairs

Lisa Huettel, PhD, Associate Dean for Undergraduate Education

Vivek Rao, PhD, Associate Dean for Master's & Professional Programs

Jim Ruth, Senior Associate Dean and Director of Development

Adrienne Stiff-Roberts, PhD, Associate Dean for Community-based Innovation

Henri Gavin, PhD, Chair, Department of Civil and Environmental Engineering

Sharon Gerecht, PhD, Chair, Department of Biomedical Engineering

Helen Li, PhD, Chair, Department of Electrical and Computer Engineering

Christine Payne, PhD, Chair, Thomas Lord Department of Mechanical Engineering and Materials Science

Pratt School of Engineering Faculty

Duke Engineering faculty rank among the top in the nation in scholarly research productivity. Click here to view full profiles of faculty.

Academic Integrity

The Duke Community Standard

Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and nonacademic endeavors, and to protect and promote a culture of integrity.

To uphold the Duke Community Standard:

- I will not lie, cheat, or steal in my academic endeavors;
- I will conduct myself honorably in all my endeavors; and
- I will act if the Standard is compromised.

It is implicit that every assignment submitted was done in accordance with the Duke Community Standard.

The Reaffirmation

Upon completion of each academic assignment, students may be expected to reaffirm the above commitment by signing this statement: "I have adhered to the Duke Community Standard in completing this assignment."

Application of the Community Standard to the Pratt School of Engineering

The Duke Community Standard encompasses both academic and nonacademic endeavors. The first part of the pledge focuses on academic endeavors and includes assignments (any work, required or volunteered, submitted for review and/or academic credit) and actions that are taken to complete assignments. It also includes activities associated with a student's job search since the definition of lying includes "communicating untruths in order to gain an unfair academic or employment advantage." Some of the aspects of academic endeavors, as they apply to the master of engineering master's students, are:

Generative AI (e.g. ChatGPT). Generative AI tools such as ChatGPT may be permitted for some assignments while not permitted for other assignments. Students should provide attribution such as "Generated by ChatGPT" if a generative AI tool is used. Students should confirm for each assignment whether the use of a generative AI tool is permitted.

Group and Individual Work. In many classes there will be both group work and individual work. Students should confirm the level of consultation or collaboration that is allowed for each assignment.

Studying from old exams, assignments, and case studies. Many courses have case studies, exercises, or problems that have been used previously. Students should not use prior semesters' work to prepare for an exam or assignment unless allowed by the instructor.

Computer laboratories, library, meeting rooms, and other shared spaces and resources. There are numerous shared resources that are available to support students' studies. Use these so that they will remain in good shape and equally accessible for others.

Career Service Resources. Use these so that they will remain equally accessible for others and so that the MEM/MEng Program will remain in good standing with Career Services. Abide by Career Center policies found at careerhub.students.duke.edu.

Implicit Reaffirmation. Some instructors may not require students to include the reaffirmation on every assignment. If the instructor does not require students to write the reaffirmation ("I have adhered to the Duke Community Standard in completing this assignment") or it is omitted from the assignment, it is implicit that every assignment submitted was done in accordance with the Duke Community Standard.

The second part of the Duke Community Standard extends its reach to nonacademic activities undertaken while enrolled as a student. Students are expected:

- to observe all local, state, and federal laws and
- to abide by Duke policies including university policies on discrimination, harassment (including sexual violence and other forms of sexual misconduct), domestic violence, dating violence, and stalking. Details for these may be found at oie.duke.edu/knowledge-base/policies-statements-and-procedures.
  Any student who is arrested or receives a citation of arrest for a misdemeanor or felony must notify the Associate Dean of Master's Education of such arrest no later than seven calendar days after the arrest. If a student is convicted of a misdemeanor or felony while after application to and before graduation from Duke, he or she must inform the Associate Dean of Master's Education of such conviction (including pleas of guilty and nolo contendre) no later than seven calendar days after the conviction.

Jurisdiction

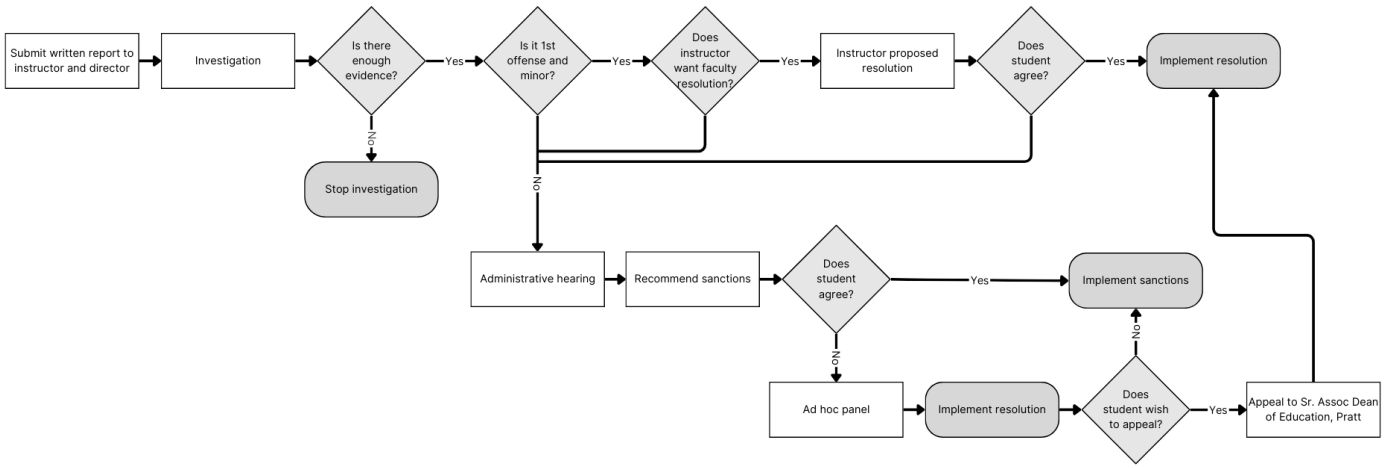
- Program leaders may respond to any complaint of behavior that occurred within a student's involvement in the academic program, from application to graduation. However, complaints of discrimination, harassment (including sexual harassment which, in turn, includes sexual violence and other forms of sexual misconduct), domestic violence, and stalking will be addressed under the Student Sexual Misconduct Policy (for misconduct by students) or the Policy on Prohibited Discrimination, Harassment, and Related Misconduct (for misconduct by employees or others).
- Any student is subject to disciplinary action. This includes students who have applied to, matriculated to, are currently enrolled in, are on leave from, or have been readmitted (following a dismissal) to programs of the university.
- With the agreement of the vice president for student affairs and the dean of the Pratt School of Engineering, jurisdiction may be extended to a student who has graduated and is alleged to have committed a violation during their career.
- The accused may also be a cohesive unit of the university, such as a recognized organization.
- The university reserves the right to take necessary and appropriate action to protect the safety and well-being of the campus community. Such action may include pursuing any violation of local, state, or federal law, or university policy—on or off campus—that constitutes a direct or indirect threat to the university community. Further, students who are cited, arrested, or reported for repeated behavioral concerns off campus may be subject to disciplinary action. Additionally, students or groups who are on university-affiliated programs/outings may be subject to disciplinary action.
- In cases of alleged policy violations by a student enrolled in a joint degree program or interdisciplinary coursework within Duke, each school or unit (the home unit and the host unit) may have a stake in the adjudication. Thus, an ad hoc process shall be developed and an ad hoc panel formed with representatives from both institutions/units to handle the case. The sanctions may be different for each school or unit.

- For students completing interinstitutional coursework at other institutions, whether domestic or international, or for visiting students enrolled in classes at Duke, the home and the host institutions should confer and decide the process to be followed, which may include combined or separate elements. The sanction may be different for each institution.

Academic Standard Resolution Process

The resolution process is the responsibility of the academic program. Electrical and Computer Engineering programs will follow their own process, which is posted on the ECE Graduate Program Sakai site. For DKU-ECE programs while students are at DKU, they will follow the DKU Academic Integrity Policy. The process below will be followed for all MEM and MENG programs.

A flow chart for the resolution process for possible violations of the academic standard is given in the figure below. The details of the process will be described in this section.



Resolution process for academic standard violations

Students' Obligation to Act on Potential Cases of Academic Dishonesty

The Duke Community Standard stresses the commitment that students share with faculty and administrators to enhance the climate for academic integrity at Duke University. The pledge beginning "I will not lie, cheat, or steal in my academic endeavors" is followed by "I will act if the standard is compromised." Both statements, like the Duke Community Standard as a whole, are statements of principles.

From principles flow policies. Stemming from this nontoleration statement ("I will act if the standard is compromised") is a policy that reflects an emphasis on taking constructive action of some sort if one witnesses or knows about dishonorable behavior connected to classroom assignments or activities.

Students who observe or hear about cheating are obligated to do something about it rather than remain passive bystanders. They are obligated to take action. Several possible courses of action are available, and students should feel free to discuss them with trusted advisors before choosing among them:

- Alerting the faculty member that cheating may be occurring in the course. This alert can be in any form, including anonymously. The information will allow the instructor to consider corrective measures and address the topic with the class.
- Calling attention to the suspected violation as it is occurring, in either a public or a private manner.
- Identifying the suspected cheater to the faculty member of the course.
- Speaking directly with the student suspected of violating the Duke Community Standard, either to gain clarity about what happened or to put the person on alert that their behavior could have serious consequences.
- Discussing concerns about a suspected violation with your program director or associate dean of the master's program.

Unless required otherwise by a court of law, the report will be treated in total confidence: if the reporting student requests anonymity, the faculty member will not divulge the reporting student's name to anyone, and the reporting student is under no obligation to take the information any place else. The faculty member will then act on this information, as the Faculty Handbook requires; at the very least, the instructor will let the suspected student know that their behavior has raised suspicion. Whatever the option chosen for reporting breaches of academic integrity, a student is responsible for doing something. This responsibility is an integral part of the Duke Community Standard and will help to build a community of honor whose values the Duke Community Standard articulates.

Investigating

Once a suspected violation has been brought to the attention of the associate dean of master's programs, they may consult with the Director of the Office of Student Conduct to decide whether any further investigation is warranted and possible. They will also assess the severity of the allegations and the associate dean of master's programs will review the disciplinary record of the person suspected to see if there are any previous violations that would preclude a "one-time faculty/student resolution." If there is to be a further investigation, the associate dean of master's programs will notify the individual/group that an academic investigation is being held and specify the university policy that is suspected of being violated. The associate dean of master's programs will

gather information regarding the alleged incident in order to determine the appropriate means of resolution. Investigations may include, but are not limited to a review of related documents, a review of electronic materials or records, and interviews, or requests for written statements from any person involved in the alleged incident. Students and student groups are encouraged to be forthright and as specific as possible when offering information related to an investigation, but may choose the extent to which they share information. Please be aware that students and organizations that lie or intentionally provide misleading information during the investigation phase or any other aspect of the judicial process are violating the Duke Community Standard. Additionally, sanctions for multiple infractions are typically more severe than sanctions for single infractions.

During the investigation, interim restrictions may be placed on a student/group to protect the health and safety of students or the community. These restrictions may include a "no contact order," removal of privileges, removal from or relocation within the residential community, suspension of activity, or suspension from the university. An interim suspension from the university may be imposed by the dean of the Pratt School of Engineering or the vice president for student affairs, or designee, and shall become effective immediately without prior notice whenever there is evidence that the continued presence of the student may pose a substantial and immediate threat to themselves, to others, or to the university community. Should an interim suspension be issued and resolution of the matter that prompted it not be resolved within two weeks, the interim suspension may convert to an administrative leave of absence.

Cases may be dropped for insufficient information, or referred for possible disciplinary action. For a case to be referred for possible disciplinary action, there must be sufficient information to believe that a policy violation may have occurred and that the alleged individual/group may be responsible.

Resolving Violations

Suspected violations are resolved dependent on their severity and the student's disciplinary history.

One-Time Student-Faculty Resolution. When the suspected violation is "minimal," such that it would not put the student at risk of suspension or expulsion (e.g., inadvertent omission of a citation or improper citation, minor misunderstanding about collaboration or use of materials on an assignment), and when the student has not committed any previous violations, it may be possible to resolve the situation at the level of the faculty member in charge of the course and the student. The first, and essential, stage in this process is for the faculty member to discuss the situation with the associate dean of master's programs to determine if the suspected violation is in fact "minimal," and if the student has previously been found responsible for any academic integrity violations. The associate dean of master's programs in consultation with the Director of the Office of Student Conduct serves as a "clearinghouse" for Duke Community Standard violations, so that

- there is consistency in defining what violations are "minimal";
- the consequences for various types of violations are consistent; and
- repeated violations by the same student in different courses do not go unnoticed.

When these conditions for a "one-time student-faculty resolution" are met, the instructor may impose consequences for the violation and inform the associate dean of master's programs of the consequences. These could include receiving failing grades on the assignment or the course, repeating one or more assignments, and/or completing a separate assignment intended to inform the student about academic integrity (e.g., a paper analyzing the consequences of failure to cite sources properly).

If the instructor does not want to use this option, they may request an administrative hearing. If the student does not agree with the resolution proposed by the instructor, they may request an administrative hearing.

Administrative Hearing. If the suspected violation is not "minimal," if there have been previous violations, if the instructor chooses not to resolve the case, or if the student disagrees with the instructor's proposed resolution, the case goes to an administrative hearing. If the violation is severe enough to put the student at risk of suspension or dismissal, and if the accused student denies the accusation, they may ask to bypass the administrative hearing level and go directly to an ad hoc judicial panel, as explained below.

If the student admits to violating the policy and accepts responsibility for their actions, the associate dean of master's programs, in consultation with the Director of the Office of Student Conduct, will recommend the appropriate disciplinary action. Consequences may include probation, suspension, or expulsion, and/or assignments intended to educate the student about academic standards. Consequences may include recommendations to the course instructor involving grades for one or more assignments or for the whole course, but final authority for these rests with the instructor.

If the student believes the administrative hearing failed to consider relevant information, violated fair procedures in some other way, or imposed consequences inappropriate to the offense, and faces potential suspension or expulsion from the university, they may appeal the decision to an ad hoc student conduct panel. If the student does not admit violating the policy and faces potential suspension or expulsion from the university, the case will be presented to an ad hoc student conduct panel.

For matters that do not involve suspension or expulsion from the university, the appeal process for the outcome of an administrative hearing can be found in the Appeals section of the Bulletin under "Appealing an Academic-, Conduct- or Complaint-Related Decision".

Ad Hoc Student Conduct Panel. Appeals from the administrative hearing stage will be heard by an ad hoc student conduct panel composed of four members, two students, and two faculty or staff members from the Pratt School of Engineering. The associate dean of master's programs will be present to help maintain continuity and consistency of procedures, but will not be a voting member of that panel. The student members will be selected by the MEM/MEng Graduate and Professional Student Government representative(s). If no representatives have yet been elected, the students will be selected by the associate dean of master's programs. The faculty/staff members will be selected by the associate dean of master's programs. The student suspected of the violation may object in writing if they believe any member of the proposed panel has a conflict of interest that could jeopardize a fair judgment. All members of the panel and the accused student should be notified at least forty-eight hours in advance when and where the hearing will be and what evidence will

be presented. Any of the student conduct panel members or the student may ask for evidence to be presented. The accused student may consult others for advice at their discretion and may bring a member of the Duke community (student, faculty, or staff member) to the hearing as an advisor (but the advisor does not speak to the student conduct panel or any witnesses). The panel will attempt to decide, using a clear and convincing standard, whether a violation took place and what the consequences should be by consensus; where consensus is not possible, a vote will determine the outcome (thus, a 3-1 or 4-0 vote is necessary to reach a conclusion). Consequences may include probation, suspension, or expulsion, and/or assignments intended to educate the student about academic standards. Consequences may include recommendations to the course instructor involving grades for one or more assignments or for the whole course, but final authority for these rests with the instructor.

Ad hoc student conduct panels are not trials and are not constrained by rules of procedure and evidence typically used in a court of law. The university disciplinary system operates under a standard of fairness, which includes an opportunity for the student/group to be notified of the alleged incident and policy violations under consideration and an opportunity to be heard.

Accused students are entitled to the following procedural rights in a hearing before the ad hoc conduct panel:

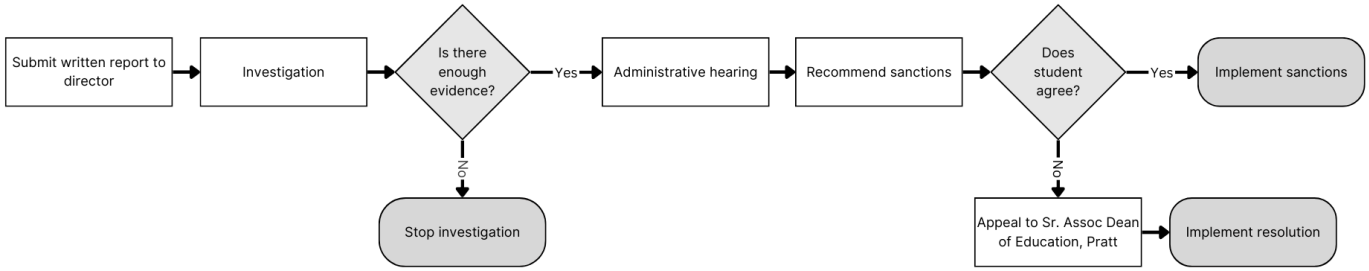
- to be informed that the student is under investigation;
- to seek advice from anyone;
- to be given an opportunity to respond to allegations;
- to choose the extent to which the student shares information (false or misleading information will be viewed as lying);
- to be notified of a hearing at least 48 hours (two days) in advance (notification will include the time, date, and location of the hearing as well as names of hearing panel members and witnesses);
- to know of and review in advance of the conduct panel written information deemed relevant by the associate dean of master's programs and allegations presented to the hearing panel;
- to challenge the participation of any panel member if there is a significant conflict of interest;
- to rebut any witness testimony presented against the student/student group while following the protocols of the hearing;
- to be accompanied by an advisor to the hearing (who must be a member of the university community [student, faculty, or staff]);
- to an equitable and impartial hearing;
- to present additional witnesses or information at the hearing (the relevancy of which may be determined by the hearing panel); and
- to appeal based upon clearly stated grounds.

If the student believes the ad hoc student conduct panel failed to consider relevant information, violated fair procedures in some other way, or imposed consequences inappropriate to the offense, they may appeal the decision by following the guidelines in the Appeals section of the Bulletin under "Appealing an Academic-, Conduct- or Complaint-Related Decision". This appeal must be made within seven days of the ad hoc student conduct panel's decision.

Upon proper notice, if a student or student group fails to attend an administrative hearing or conduct panel, the hearing officer may proceed to resolve the case without the benefit of that student's/student group's input.

Nonacademic Standard Resolution Process

A flow chart for the resolution process for possible violations of the nonacademic standard is given in the figure below. The details of the process will be described in this section.



Resolution process for nonacademic standard violations

Investigating. Once a suspected violation has been brought to the attention of the associate dean of master's programs, they will consult with the Director of the Office of Student Conduct to decide whether any further investigation is warranted and possible. (Again, allegations of harassment will be handled under either the Student Sexual Misconduct Policy or the Policy on Prohibited Discrimination, Harassment, and Related Misconduct.) If there is to be a further investigation, the associate dean of master's programs, will notify the individual/group that an investigation is being held and specify the university policy that is suspected of being violated. They will gather information regarding the alleged incident in order to determine the appropriate means of resolution. Investigations may include a review of related documents, interviews, or requests for written statements from any person involved in the alleged incident. Please be aware that students and organizations that lie during the investigation phase or any other aspect of the process are violating the Duke Community Standard. Additionally, sanctions for multiple infractions are typically more severe than sanctions for single infractions.

In cases where local, state, and/or federal laws may have been violated, the investigation may be postponed until the outcome of the legal investigation has been completed. Additionally, prior to investigation and resolution, interim restrictions may be placed on a student/group to protect the health and safety of students or the community. These restrictions may include a "no contact order," removal of privileges, removal from or relocation within the residential community, suspension of activity, or suspension from the university. An interim suspension from the university may be imposed by the dean of the Pratt School of Engineering or the vice president for student affairs, or designee, and shall become effective immediately without prior notice whenever there is evidence that the continued presence of the student may pose a substantial and immediate threat to themselves, to others, or to the university community. Should an interim suspension be issued and resolution of the matter that prompted it not be resolved within two weeks, the interim suspension may convert to an administrative leave of absence.

Cases may be dropped for insufficient information, or referred for possible disciplinary action. In order for a case to be referred for possible disciplinary action, there must be sufficient information to believe that a policy violation may have occurred and that the alleged individual/group may be responsible.

Resolving Violations. Alleged nonacademic violations are handled by administrative hearings. If the student admits to violating the policy and accepts responsibility for their actions, the associate dean of master's programs will recommend the appropriate disciplinary action. Consequences may include probation, suspension, or expulsion, and/or assignments intended to educate the student about appropriate community behavior.

If the student believes the administrative hearing failed to consider relevant information, violated fair procedures in some other way, or imposed consequences inappropriate to the offense, they may follow the process found in the Appeals section of the Bulletin under "Appealing an Academic-, Conduct- or Complaint-Related Decision". This appeal must be made within seven days of the administrative hearing's decision.

Confidentiality

Information gathered in the process of resolving alleged Duke Community Standard violations is confidential. Information may be shared with the following entities or under the following circumstances:

- with the accused student to inform them that they have been accused
- with school officials with legitimate interest, such as the instructor of the class, administrators, Office of Student Affairs, Office of Student Conduct, Office of Institutional Equity
- to comply with a judicial order or lawfully issued subpoena
- to appropriate officials in cases of health and safety emergencies
- for any students involved in a joint-degree program or interdisciplinary coursework, with the other degree program
- for students involved in interinstitutional coursework, with the other institution

Information about Duke Community Standard violations, their disposition, and consequences may be shared, with any identifying information removed, for the purposes of

- educating students and faculty about Duke Community Standard violations;
- ensuring consistency in responding to Duke Community Standard violations; and
- reporting on Duke Community Standard violations to the university or to facilitate research on academic integrity.

Appealing an Academic-, Conduct- or Complaint-Related Decision

In the event that a student wishes to appeal a decision, appeals are reviewed by the Pratt Professional Programs Appellate Panel and the following procedures govern the appeals process.

Pratt Professional Programs Appellate Panel Composition and Authority

The Pratt Professional Programs Appellate Panel will consist of the following leadership of the Pratt School:

- Associate Dean for Research (Appellate Panel Chair)
- Associate Dean for Doctoral Education
- Associate Dean for Undergraduate Education

This Panel will review appeals of decisions that relate to academic performance, admissions revocation, program complaints, academic and non-academic misconduct. For the purposes of this procedure document, the above issues are implied by the phrase "academic-, conduct-, or complaint-related decisions."

Appeal Timeline

An appeal must be filed in writing with the Pratt Professional Programs Appellate Panel no more than 10 calendar days after a decision has been formally communicated by the Associate Dean for Masters and Professional Programs to the student in question. Appeals must follow the procedures below (see "Appeal Statement").

Grounds for Appeal

An appeal is not a re-hearing of a case. There are two admissible grounds for appeal:

1. New information not reasonably available at the time of decision that is material to the decision is now available; and/or
2. Procedural error(s) that materially impacted the decision occurred.

Appeal Statement

Academic-, conduct-, and complaint-related decisions from the Associate Dean for Masters and Professional Programs will contain instructions on how to submit an appeal statement. All appeals must:

1. Clearly state the ground(s) for appeal.
2. Not exceed more than two (2) pages (12-point font, 1-inch margins).

No information or correspondence initiated by the appellant beyond the Appeal Statement will be considered in the Appellate Panel's review.

The Appellate Panel Chair may request meetings with the appellant and/or other parties at the Chair's discretion.

The Associate Dean for Masters and Professional Programs will prepare a one (1) page response statement to accompany the appellant's appeal statement, for review by the appellate committee.

Appeal Exceptions

The appellant may submit to the chair requests for exceptions to page limits or deadlines within 7 days of the original decision that is being appealed was formally communicated by the Associate Dean for Masters and Professional Programs to the student in question.

Exceptions must be requested in this period by sending an email to the Appellate Panel Chair, with justification for such request(s). If either party fails to meet a deadline or exceeds page limits without receiving an exception, the Appellate Panel Chair has the discretion to summarily reject an appeal or the appellate panel may disregard the response.

Appeals Decisions

Appeals decisions will be determined by a majority vote of the Appellate Panel.

The Appellate Panel Chair will typically notify the parties of its decision regarding an appeal in writing within 20 business days from receipt of the appeal statement. If the decision will take longer, the Chair will inform the parties.

The Appellate Panel Chair will provide written notification of the final decision to the appellant (and appellee, if applicable, at approximately the same time).

The Appellate Panel decision is the final avenue for appeal.

Student Resources

Career and Communication

GSPS: Career & Communication is a career and communication resource center designed to provide graduate students at the Pratt School of Engineering with courses, workshops, and one-to-one and group support in the areas of oral and written communication for academic and professional purposes, as well as career development and search strategies. Career and Communication serves domestic and international students and offers a combination of resources targeted to serve engineers from all backgrounds.

Graduate Student Groups

There are many ways to get involved, make a difference, and connect with fellow students at the Pratt School of Engineering. Pratt has many different student groups that exist within departments, as well as the Engineering Master's Student Advisory Board, Engineering Graduate Student Council, and Pratt Peers Student Support Network, which span across all programs and departments. Additionally, the Graduate and Professional Student Government connects and advocates for all of Duke's graduate and professional students. Students who are interested in learning more about how to get involved should email Pratt-GSPS@duke.edu.

Student Experience and Strategic Partnerships

GSPS: Student Experience and Strategic Partnerships is dedicated to fostering community and providing comprehensive support for all graduate and professional engineering students. From onboarding and orientation through graduation, Student Experience and Strategic Partnerships encourages students to actively engage with the vibrant Pratt community. The team offers personalized guidance to help students navigate a broad range of personal and professional challenges, fostering a well-rounded and enriching experience throughout their time at Duke. In addition, Student Experience and Strategic Partnerships facilitates meaningful connections with alumni and industry partners to support students' career development and expand their professional networks.

Academic Policies

Academic policies differ slightly between the Master of Engineering and Master of Engineering Management programs. Policies are detailed within the Programs section of this bulletin. Find the MEM academic policies here and the MEng academic policies here.

Admissions

Application Requirements

Applications are accepted for the fall semester only for most programs. The **MEM online program** accepts applicants for fall and spring semesters.

Admission requires the following:

- a bachelor's degree in engineering, science, or a related field from an accredited institution (transcripts required, including an estimated GPA)*
- short answer essays*
- résumé*
- three recommendations*
- Graduate Record Exam (GRE) results or equivalent**
- Test of English as a Foreign Language (TOEFL) the International English Language Testing System (IELTS) exam, or Duolingo English Test results (international applicants only)
- a nonrefundable application fee of $75 USD to be paid via credit card*
- a video introduction*
- an interview may be required for select programs/applicants

For more information on the application requirements, see the MEM and/or MEng websites.

*Items that can be submitted online using the online application.

**Submitting GRE results is optional for the 2025-2026 academic year.

International Applicants

Unlike many schools, Duke does not require financial support documents as part of the application; instead, students submit this information after they have been admitted and are enrolled in the program.

Duke does not automatically issue I-20s/DS-2019s to students upon admission. Instead, students work with the admissions office to submit information and supporting documents to Duke's Visa Services Office.

Upon accepting the offer of admission, a student will receive an email from the admissions office with credentials to commence the visa process.

Application Deadlines

Applications are reviewed after they are received, and applicants should submit their application materials as early as possible but before the deadlines listed on the MEM and/or MEng websites. An application is not considered complete until every component has been received, and an application must be complete by a round's deadline in order to be considered for that round.

In some cases, a program may postpone a decision to the next round. Admitted students may request to defer admission for up to one year.

Admission Revocation

The Pratt Professional School reserves the right to rescind any applicant's admission to the program if new information arises pertaining to significant academic performance issues, criminal activity, Duke Community Standard violations, or other extraordinary circumstances. In general, significant issues that justify withdrawing an offer of admission would be those that could lead to a suspension or dismissal if a student were already enrolled in the MEM or MEng programs.

Decisions to revoke admissions will be made by the MEM or MEng Program Admissions Committee, and appeals will be heard by the Associate Dean for Research and Infrastructure.

Tuition & Fees – Duke University MEM & MEng

Tuition for the 2025-2026 academic year is $34,800 (MEM) or $34,100 (MEng) per semester. In general, completion of the eight required program courses would result in a total tuition cost of $69,600 for MEM students. For MEng campus students, completion of the 30.0 required credits over three semesters would result in a total tuition cost of $102,930. For MEng online students, completion of the 30.0 required credits over five semesters would result in a total tuition cost of $72,300.

Part-time MEM campus students and students in standalone graduate certificate programs pay $2,900 by course unit. Part-time MEng campus students pay $3,431 by course unit.

Estimated Full-Time Student Expenses for the 2025-2026 Academic Year

	MEM ON-CAMPUS STUDENTS	MEM ONLINE STUDENTS	MENG ON-CAMPUS STUDENTS	MENG ONLINE STUDENTS
Tuition	$69,600 ($34,800/ semester)	$69,600 ($17,400/ semester)	$68,620 ($34,310/semester)	$72,300 ($14,460/ semester)
Health Fee	$996*	-	$996*	-
Health Insurance	$3,565**	-	$3,565**	-
Graduate Student Activity Fee	$37	-	$37	-
Graduate and Professional Student Services	$25	-	$25	-
Transcript Fee (one-time fee)	$120*	$120*	$120*	$120*
Recreation Fee	$392	-	$392	-
Room	$13,842*	$4,500 ($1,500 residency)	$13,842*	-
Board	$4,320*	-	$4,320*	-
Books	$660*	$660*	$660*	$660*
Transportation and Miscellaneous	$6,462*	-	$6,462*	-
Total	**$100,019**	**$74,880**	**$99,039**	**$73,080**

*Fees and estimates subject to confirmation each May

**Required unless a student can show proof of comparable private insurance coverage

The cost of living—which includes room, board, and transportation, among other miscellaneous costs—is estimated for the academic year. The actual cost of living depends on individual lifestyle. Cost may also differ for international students.

Audit Fees

Auditors are permitted on a space-available basis with the consent of the instructor. Students charged tuition on a per-semester basis may audit courses without charge. Students who have selected the pay-per-unit billing option may audit courses but will incur a $535 fee for each audited course.

Co-op Fees

Students participating in the Co-op Program will incur a $300 fee each term they are participating in a co-op and are enrolled in the co-op course.

Tuition & Fees

Tuition & Fees – Duke Kunshan University

Program tuition for the 2025-2026 academic year is $34,310 for non-PRC students and ¥105,000 for PRC students per semester taken at Duke Kunshan University. It is $34,310 per semester for all students taken at Duke University. The internship courses do not incur tuition charges. Students enrolled in the Duke Kunshan MEng program may not enroll in a part-time course load while studying at Duke University.

Students pay Duke Kunshan tuition and fees for the first two semesters of enrollment, and Duke University tuition and fees for their third and fourth terms of enrollment.

Estimated Cost of Attendance for the 2025-2026 Academic Year

	NON-PRC STUDENTS	PRC STUDENTS
Tuition	$68,620 ($34,310/semester)	¥210,000 (¥105,000/semester)
Health Insurance	$1,386	¥800
Books & Supplies	$632	¥4,544
Residence	$3,616	¥26,000
Board	$2,921	¥21,000
Domestic/International Travel	$3,000	¥3,000
Transportation and Misc.	$1,669	¥12,000
Total	$81,844	¥277,344

The figures in this section are projections and are subject to change. Certain basic expenditures, such as tuition and room and board are considered in preparing a student's budget. These necessary expenditures, with a reasonable amount allotted for miscellaneous items, are shown below:

- The normal program duration is two years of study (four semesters).
- The normal load is three courses per semester in the first year.
- There is no charge for registration for students in the Master of Engineering Program.
- All fees and rates provided at this time are estimates and are subject to change.
- Duke Kunshan student residence and dining facilities are closed during the winter break between the fall and spring semesters.
- DKU residence charge for a single room is 13,000 RMB/1,808 USD or 11,000RMB/1,530 USD per semester, the double room is 9,250 RMB/1,287 USD per semester.
- International Travel includes an estimate of the cost of one roundtrip from an international destination to Shanghai for international students, typical visa costs, and in case of additional health checks and registration costs associated with establishing legal residence in China for non-Chinese students. Students wishing to return to their home countries during breaks in their studies before the end of the year should budget additional funds for these trips.
- Domestic travel includes two return trips (RMB 1,000 each) for PRC students to go back home during Chinese vacation.
- International students are required to purchase and enroll in the Health Insurance Plan (including SOS) from the university. For detailed insurance information, visit dukekunshan.edu.cn/en/campus-life/student-life/pre-arrival-and-orientation/international-student-zone#pre-insu.
- Tuition and related fees are due before the start of each semester. It is the responsibility of students to pay the full billed amount by the due date listed on the bill. Students applying for financial aid should complete that process by the specified due date.
- Students who receive the RMB invoice should pay in RMB; while students who receive the USD invoice should pay in USD. For detailed payment instructions, refer to the student bill Student Finance at dku-bursar@dukekunshan.edu.cn.
- Service charges are normally assessed by both the sending bank and intermediary bank involved in completing the wire transfer. Please make sure you include or pay the service charge before initiating your wire transfer. Your student account will be credited for the actual amount received (net of fees assessed by the sending banks).

Tuition & Fees

Tuition Policies

Payment of Accounts

The Office of the Bursar will issue invoices to registered students for tuition, fees, and other charges approximately four to six weeks prior to the beginning of classes each semester. The total amount due on the invoice is payable by the invoice late payment date which is normally one week prior to the beginning of classes. A student is required to pay all invoices as presented and will be in default if the total amount is not paid in full by the due date. A student in default will not be allowed to receive a diploma at graduation. Inquiries regarding statements can be directed to the bursar's office at bursar@duke.edu or (919) 684-3531.

Payment of Accounts for Fall and Spring

As part of the admission agreement to Duke University, students are required to pay all statements as presented. If full payment is not received, a late payment penalty charge on the past due amount is charged on the subsequent statement. The past due amount is defined as the amount due from the previous statement minus payments, financial aid, loans, and other credits received prior to the due date listed on the prior statement. Failure to receive an invoice does not warrant exemption from the payment of tuition and fees nor from the penalties and restrictions. Nonregistered students will be required to make payment for tuition, fees, and other charges at the time of registration.

In addition to late payment charges, students with accounts in default may be subject to the following restrictions:

- blocked from registering for future terms
- blocked from access to copies of transcript of academic records
- not able to have academic credits certified
- not be permitted to go on leave of absence
- not eligible to receive a diploma at graduation
- subject to withdrawal from the university
- subject to having the past due student account referred to a collection agency and credit bureaus

Refunds for Withdrawal from School during Fall and Spring Semesters

In the event of death, refund of full tuition and fees for the term will be granted. In all other cases of withdrawal from the university, students may have tuition refunded according to the following schedule:

TIME OF WITHDRAWAL	REFUND AMOUNT
withdrawal before classes begin	100% (including fees)
withdrawal during the first or second week of classes	80%*
withdrawal during the third, fourth, or fifth week of classes	60%*
withdrawal during the sixth week of classes	20%*
withdrawal after the sixth week	No refund

*Fees are not refunded after the start of the term

Tuition charges paid from grants or loans will be restored to those funds on the same pro rata basis and will not be refunded or carried forward.

MEM-Specific Tuition Policies

Full-time residential students. Students enrolled in the MEM Program as full-time residential students will automatically be set up for a pay-per-semester billing system, meaning they will be charged the equivalent of four separate courses in their first **two** semesters of enrollment. In the **third** semester, residential students will not incur tuition charges, but will be charged any applicable student fees.

Residential students who continue into a **fourth** semester will be charged tuition at a per-credit rate, in addition to any applicable student fees. Per-credit payment may be requested in the fourth term only by contacting the Pratt Student Records Coordinator. For the 2025-2026 school year, the per-credit rate is $2,900. The last day to request this change is the end of drop/add for the term.

MEM Online students. Students enrolling in the MEM Online Program will automatically be set up for pay-per-semester billing system, meaning they be charged the equivalent of two separate courses. Students in the MEM Online Program may take three tuition-bearing courses in a semester and only pay the cost of two courses under the pay-per-semester billing option if they have already completed and paid the cost of four courses. MEM Online students may take a maximum of two free courses throughout the program.

MEM Online students who are only registered for one tuition-bearing course per term may be considered part-time students and may request to be moved to a per-credit billing system by contacting the Pratt Student Records Coordinator. For the 2025-2026 school year, the per-credit rate is $2,900. The last day to request this change is the end of drop/add for the term.

MEng-Specific Tuition Policies

Full-time residential students. Students enrolled in the MEng programs as full-time residential students will automatically be set up for a pay-per-semester billing system, meaning they will be charged the equivalent of 10 credits of courses in each their first **three** semesters of enrollment.

Residential students who continue into a fourth semester will be charged tuition at a per-credit rate, in addition to any applicable student fees. Per-credit payment may be requested in the **fourth** term only by contacting the Pratt Student Records Coordinator. For the 2025-2026 school year, the per-credit rate is $3,431. The last day to request this change is the end of drop/add for the term.

MEng Online students. Students enrolling in the MEng Online programs will automatically be set up for pay-per-semester billing system, meaning they be charged the equivalent of two separate courses. MEng students may take a maximum of 2 classes per term under the per-semester billing system.

MEng Online students who are only registered for one tuition-bearing course per term may be considered part-time students and may request to be moved to a per-credit billing system by contacting the Pratt Student Records Coordinator. For the 2025-2026 school year, the per-credit rate is $2,410. The last day to request this change is the end of drop/add for the term.

Program Specific Tuition Policies

Tuition policies vary for students in the AIPI Program and Pratt 4+1 students. Students should reference the appropriate website for program specific tuition information. Students in the Accelerated Financial Technology program will follow the same policies as the traditional Financial Technology program, with the three semesters of per-semester tuition charged in Summer, Fall and Spring. Students in any program enrolling in courses outside of Pratt during a summer term will be charged tuition and fees determined by the program the course is a part of (i.e. Undergraduate or Graduate school courses).

Financial Aid

Because Pratt offers professional degrees rather than research degrees, most students pay their tuition costs.

Loans

US citizens and eligible noncitizens are able to borrow through the Federal Stafford Loan Program. Applicants for assistance through this program must file a Free Application for Federal Student Aid (FAFSA), which may be completed online at studentaid.gov/h/apply-for-aid/fafsa. When completing the online form students will be asked for Duke's Title IV Code; it is E00165.

Maximum eligibility under the Stafford Unsubsidized Loan Program is $20,500 per year with an aggregate limit of $138,500. For further information on the FAFSA and the US Department of Education's Stafford Loan Program, call (800) 433-3243.

Students awarded Federal loans must make satisfactory academic progress toward their degree and must be enrolled in 9 graduate-level credits per semester.

International applicants are not eligible for federal loans; however, many international students take out loans in their home countries, and some US banks may offer loans to international students for study in the United States. Duke maintains information on lenders for US citizens, permanent residents, and non-US citizens.

Scholarship

The MEng Program has limited financial aid available to highly qualified candidates through academic scholarships. Mission Scholarships are offered to selected students demonstrating a commitment to fostering a community of unique lived experiences and perspectives. See pratt.duke.edu/admissions/financial-support for more information about financial aid.

The MEM Program has additional financial assistance available through the Wilkinson and Garda Scholarships for Outstanding Students. See masters.pratt.duke.edu/admissions/tuition-financial-aid for more information about scholarships.

DoD SMART Scholarship Program (US Citizens Only)

The Science, Mathematics, and Research for Transformation (SMART) Scholarship for Service Program has been established by the Department of Defense (DoD) to support undergraduate and graduate students pursuing degrees in Science, Technology, Engineering, and Mathematics (STEM) disciplines. The program aims to increase the number of civilian scientists and engineers working at DoD laboratories. See smartscholarship.org/smart for more information.

VA Benefits

Duke University offers information for veterans who are applying for VA benefits, including the Yellow Ribbon Program. See registrar.duke.edu/veterans/tuition-assistance-benefits for more information.

On-Campus Work

While enrolled in the program, many students work in a variety of places, such as campus libraries, and various departments within Duke University. Teaching assistantships are available in various departments, and some departments have research assistantships as well. These positions are paid an hourly rate, and most students work between ten and twenty hours per week. Some positions are generally posted and filled just a week or two before classes begin each semester. See duke.studentemployment.ngwebsolutions.com for more information.

All Programs

Master's Programs

Master of Engineering

Artificial Intelligence for Product Innovation (also offered online)
Biomedical Engineering
Civil Engineering
Climate and Sustainability Engineering
Computational Mechanics and Scientific Computing
Cybersecurity (also offered online)
Design and Technology Innovation
Electrical and Computer Engineering (also offered through Duke Kunshan University)
Environmental Engineering
Financial Technology (also offered online)
Game Design, Development, and Innovation
Materials Science and Engineering
Mechanical Engineering
Medical Technology Design
Photonics and Optical Sciences
Risk Engineering
Robotics and Autonomy
Master of Engineering Management (also offered online)

Certificates

Concurrent Graduate Certificates

Aerospace
AI for Materials (aiM)
Biomedical Data Science
Biotechnology

Computational and Digital Health
Medical Device Design
Medical Robotics and Surgical Technologies
Neural Engineering
Robotics and Automation

Standalone Graduate Certificates

AI Foundations for Product Innovation
Business Foundations for Engineers
Innovation for Defense

Early Career & 4+1 Programs

Early Career Program and 4+1 Program for Duke Students

Master of Engineering Overview

Program Summary

The Master of Engineering (MEng) Program began in 2010 and provides students with the skills to effectively contribute to the technical needs of the twenty-first century global organization immediately upon graduation. The MEng degree is an applied, nonthesis degree that has a single departmental or program affiliation, or a defined interdisciplinary affiliation across more than one department.

As an applied, nonthesis degree, the MEng degree provides differentiated value by coupling graduate-level technical knowledge in key areas of strength with core business fundamentals, thus better preparing students to work in the industry. The MEng degree is housed in, and managed by, the Pratt School of Engineering with faculty oversight provided by engineering school faculty through the Engineering Faculty Council and the existing departments and programs. The MEng degree positioned the Pratt School of Engineering to take a leadership role in developing a professional master's curriculum that delivers state-of-the-art technical depth coupled with necessary business knowledge breadth to produce graduates who can truly impact their organizations.

See Master of Engineering Academic Policies.

The disciplines within the Master of Engineering degree are:

- Artificial Intelligence for Product Innovation (also offered online)
- Biomedical Engineering
- Civil Engineering
- Climate and Sustainability Engineering
- Computational Mechanics and Scientific Computing
- Cybersecurity (also offered online)
- Design and Technology Innovation
- Electrical and Computer Engineering (also offered through Duke Kunshan University)
- Environmental Engineering
- Financial Technology (also offered online)
- Game Design, Development, and Innovation
- Materials Science and Engineering
- Mechanical Engineering
- Medical Technology Design
- Photonics and Optical Sciences
- Risk Engineering
- Robotics and Autonomy

Master of Engineering Academic Policies

Academic Freedom

Freedom of inquiry and the free exchange of ideas are essential for the fulfillment of the university's mission. Academic freedom is a right and responsibility of students as well as faculty. Students who believe that their academic freedom has been abridged should submit a written complaint to the associate dean of master's program. The associate dean of master's program may enlist the associate dean for faculty affairs and community engagement to provide advice. Cases not resolved by the associate dean of master's program may be brought to the attention of the provost. Students may also seek advice of the student ombudsperson in resolving a complaint.

Academic Standing and Satisfactory Academic Progress

To maintain satisfactory academic progress (SAP), students must achieve a required minimum grade point average (GPA) of 3.0, complete two-thirds (67%) of cumulative attempted courses, and are limited to a maximum of 45.0 attempted credits. Attempted and completed courses include courses for which A-F letter grades or (CR) Credit/(NC) No Credit were assigned. Attempted but not completed courses include courses with grades of (I)ncomplete or (W)ithdrawn. Courses that are not counted in the attempted calculation include EGRCOOP, courses taken for audit and courses with grades of (Z) Continuing or (N)o grade given.

The short duration of the program means that these requirements must be taken very seriously by all students immediately upon entry into the program. Students who do not make satisfactory academic progress or who receive an F in any course may be subject to academic disciplinary action. These actions may include academic probation, suspension, or dismissal. Academic probation means that the student is in danger of being suspended or dismissed from the program. It also means that the student should take immediate action to be more successful academically. A variety of actions may be required when a student is placed on academic probation, including, but not limited to, tutoring, exclusion from extracurricular activities, enrollment in specific courses, and/or limiting the number of classes taken in a semester. In addition, students must have a grade point average of B (3.0) or better to graduate.

Suspension, dismissal, and graduation are authorized by the Associate Dean of Master's Programs. If the student believes the process failed to consider relevant information, violated fair procedures in some other way, or imposed consequences inappropriate to the offense, they may appeal the suspension, dismissal, or graduation decision within seven days by following the process in the Appeals section of the Bulletin under "Appealing an Academic-, Conduct- or Complaint-Related Decision".

Admission Revocation

The MEng Program reserves the right to rescind any applicant's admission to the program if new information arises pertaining to significant academic performance issues, criminal activity, Duke Community Standard violations, or other extraordinary circumstances. In general, significant issues that justify withdrawing an offer of admission would be those that could lead to a suspension or dismissal if a student were already enrolled in the MEng Program.

Decisions to revoke admissions will be made by the Associate Dean for Master's Education, and appeals will be heard by following the process in the Appeals section of the Bulletin under "Appealing an Academic-, Conduct- or Complaint-Related Decision".

Advising

Academic plans for the MEng students must be approved by an academic advisor. The implementation of this requirement will be determined by each major but could include an overall plan of study approval, a semester by semester approval of course choices, and/or advising sessions for incoming students. A menu of course options can be an aid in this advising process. The student is responsible for determining that their plan of work will satisfy all graduation requirements for their major.

Audits

Audits are permitted on a space-available basis with the consent of the instructor and the director of master of engineering studies (DMS) for the student's major (see Audit Permission Form). Students may only audit one course per fall and spring semesters.

The fee for auditing a course depends on a student's tuition payment option. Degree students registered for regular MEng courses and who are charged tuition on a per-semester basis may audit an additional course without being charged. Degree students registered for regular MEng courses and who have selected the pay-by-credit payment option may audit a course but will incur an audit fee of $535 for each course audited. This policy is in effect for all students, even if a student decides to change from pay-by-semester to pay-by-credit in their last semester of the program.

It is important that students understand an instructor's expectations for auditing students, such as assignments, readings, class participation, etc. Auditing students must comply with these requests to successfully complete the audit, as it is possible to fail.

Note that degree students may unofficially sit in on courses with just the permission of the instructor; no forms are necessary in this case. Generally, nondegree seeking students may not audit or sit in on courses; however, alumni of the MEng Program, and Post-docs who wish to audit classes for personal or professional development will be considered on a case-by-case basis.

Complaints

If a student has a concern with a course or with an aspect of the program, the concern should first be addressed to the faculty or staff member most associated with the area of concern. If the faculty or staff member is not able to address the concern, the matter may be brought to the attention of the appropriate DMS to address the situation. If a significant concern has not been addressed by the DMS, the matter may be escalated to the associate dean of master's program. Complaint responses from the associate dean of master's program may be appealed by following the process in the Appeals section of the Bulletin under "Appealing an Academic-, Conduct- or Complaint-Related Decision".

Concurrent MEng and PhD Degrees

Students getting their PhD degree from the Pratt School of Engineering may also want to pursue a MEng degree to obtain the breadth found in the MEng core courses. To facilitate this, PhD students may utilize their PhD courses to fulfill the technical course requirements of the MEng degree (i.e., the eight noncore course requirements) if those courses meet the curricular requirements of the MEng major of interest. Thus, PhD students may obtain the MEng degree by adding the two MEng core courses to their coursework and fulfilling the internship requirements. Note that generally, the student's PhD research will not be

acceptable as the internship experience for the concurrent MEng degree. Students must apply for the MEng Program independently from the PhD and must be enrolled in the MEng Program (i.e., dual enrolled in the MEng and PhD) before taking the MEng core courses. Students should register for these MEng core courses separately from their PhD courses under their MEng shopping cart and will be billed for these courses separately from their PhD. Other MEng courses to be utilized to fulfill the MEng requirements may be taken at any time while a PhD student, before or after enrolling in the MEng Program. Note that being accepted as a PhD student does not guarantee acceptance as a MEng student. Note that students will generally receive their MEng degree at the same time or after receiving their PhD. If a student does not obtain a PhD, only four of the technical courses taken as a PhD student may be applied to the MEng degree. The other four technical MEng course requirements and the MEng core courses must be taken after enrollment in the MEng Program. All PhD students should discuss their plans with their faculty advisor for their research program and with the DMS for their major of interest. When applying for the MEng degree, the student should indicate they are already a PhD student and plan to do the MEng concurrently with their PhD.

Changing a Course

MEng courses generally follow the calendar for graduate students on the university registrar's website (registrar.duke.edu/current-academic-calendar), including Drop/Add dates. This applies to master of engineering courses and courses under The Graduate School oversight.

A student seeking a course withdrawal after the end of the Drop/Add period will first meet with their DMS to discuss eligibility and desirability of making a change in the student's semester schedule. In general, students found responsible for academic cheating in a course with a consequence of a reduced grade will not be eligible to withdraw from that class. If the student is authorized to withdraw by the DMS, the student will seek a signature from the course instructor. The requirement for the instructor's signature provides an opportunity for the student to discuss the issues leading to the student's request and to determine whether the student is fully informed about performance, grading, and readiness for the course. The signature also provides the mechanism by which instructors learn that the student will no longer be a member of the class. Withdrawal from a class after the end of the Drop/Add period will result in a W on the student's transcript.

Section Changes for Core Courses

Because the MEng Program has a short duration, some students may require a specific core Industry Prep course in a specific semester in order to graduate. Often, one or two sections of a particular core course fill up and students with elective course conflicts with the core course are unable to register. The MEng Program will initially request that students voluntarily redistribute from full sections to open sections. If a voluntary redistribution is not sufficient, students without conflicts may be randomly selected and switched to an alternate section of a core course in order to ensure that all students are able to complete their degree requirements.

Cooperative Education Program

Residential students seeking to expand on the practical training component of their degree in a manner that more closely simulates life after school may participate in the Master of Engineering Co-op Program. This program will be one of two academic pathways students can follow to earn their degree:

- The traditional full-time program with an internship requirement, typically completed as full-time work during the summer with the option to work part-time during the school year, or
- The co-op program which will allow students to work full-time, away from Duke, during the school year, while remaining enrolled as a full-time student.

Once students have completed their first semester, they may explore employment opportunities with companies to participate in a co-op during the summer and/or fall terms and will present the opportunity they have identified to the Co-op Coordinator and their Faculty Advisor so that they may apply for the Co-op Program. To be eligible to participate in the co-op program, students must have a GPA of 3.0 or higher and be in good academic and disciplinary standing at the time they enroll in the Co-op Program. The typical co-op schedule will be to do at least an 8 week co-op in the summer and/or fall terms. Students may do both co-op sessions, return to campus the following spring semester to complete their coursework and graduate in May or graduate in the same term as their co-op, depending on the requirements of their program. Depending on work authorization requirements, other options may be available.

A co-op requires three party engagement with the Student, University Faculty, and a Company Sponsor. Both the Company and the Student will be required to sign documents that define the responsibilities and expectations of each party. As a result, there is more engagement with Duke University during a co-op than with a typical internship. Students will be expected to:

- Have monthly check-ins with their faculty advisor.
- Participate in a performance assessment with the sponsoring company, Faculty Advisor and Co-op Coordinator at least every 3 months of their co-op experience.
- Complete an employer's evaluation form to the Co-op Coordinator that assesses their co-op experience.
- Receive a job performance evaluation from the sponsoring company at the conclusion of the co-op experience that is shared with the Co-op coordinator and Faculty Advisor.

General Guidelines

- Co-op should be full-time work and take place at the employers' physical location or another approved company location, including remote work.
- The minimum hourly requirement for the co-op is 320 hours (eight weeks, forty hours per week).

- Students will enroll in a 9-credit co-op course (EGRCOOP 501, 502, or 503) to maintain their full-time status as a Duke student while they are not enrolled in other courses.
    - Tuition is not charged for this course, but there will be a $300 co-op fee charged per semester.
    - Students may enroll in up to three (3) co-op experiences (EGRCOOP 501, 502, and 503). Courses may not be repeated.
    - Participating in multiple co-op experiences may extend a student's program to a maximum of 33 months of visa approval. A maximum of 1 visa extension request may be made by a student.
    - Note: Students who use 12 months or more of full-time (20 or more hours per week) CPT will have no available time for Optional Practical Training (OPT).
- Credit for co-op courses does not apply toward the 30-credit degree requirement.
- With approval of the Director of Master's Studies and the Sponsor Company, the student may take one academic class, under no circumstances to exceed 4 units, during their co-op semester. If the student will graduate during their co-op term, they may also enroll in EGRMGMT 551/MENG 551 along with the academic course. The student is responsible for the tuition for those classes at the per-credit tuition rate for their program, if applicable.
- Students may participate in a summer internship and then transition the position to a fall co-op once the required co-op paperwork has been completed. International students must apply for Curricular Practical Training (CPT) separately for the internship and co-op semesters.
- If a student is unable to complete their co-op or find another co-op opportunity, they will be returned to the standard internship pathway.
- MEng students must complete three terms on campus, not including their co-op term. Students may participate in a co-op during their 3rd term and return to campus to complete their 4th term and graduate, or they may complete three terms on campus and participate in a co-op in their 4th term and graduate in that term while taking their final course(s) (note: course(s) must be approved by DMS and Sponsor company and be no more than 4 credits total). Students who request an extension beyond the traditional 4 terms must still complete three terms on campus.
- Beginning in the Spring 2026 term, students participating in a co-op may not hold simultaneous campus employment at Duke University or the Pratt School of Engineering, e.g. as a Teaching Assistant.

Completion Requirements

- Successful completion of the co-op will be verified by the DMS/program for each discipline and will include a written and/or oral project report (implementation will be determined by each discipline, examples include: poster session, oral presentation, project report, sponsor verification, etc.).
- Students must also enroll in MENG 551 in which they will write a report about their internship experience and complete a final presentation summarizing the experience.

Courses at Nearby Universities

Under the interinstitutional registration agreement, any MEng student enrolled as a degree-seeking student at any of the following universities may take technical electives at the following universities:

- North Carolina Central University
- North Carolina State University
- The University of North Carolina at Chapel Hill
- The University of North Carolina at Charlotte
- The University of North Carolina at Greensboro

Permission of the DMS is required and students will be charged Duke University tuition rates for such courses. Distance courses may not be taken under an interinstitutional transfer agreement. More information about interinstitutional registration can be found on the university registrar's website at registrar.duke.edu/registration/interinstitutional-registration/duke-students-visiting-other-campuses.

MEng students are not permitted to take interinstitutional or non-Pratt classes during the summer. Students are also not permitted to take interinstitutional classes in their final term as late grade submission may delay graduation.

Dual-Degree and Joint Programs

Information about dual-degree options and joint programs is available at meng.pratt.duke.edu/about/options-current-duke-students-and-graduates.

Duke University Policies

Policies that apply to all students at Duke University may be found at policies.duke.edu/students. In some cases, the MEng Program may have supplemental policies to Duke University Policies. If MEng policies or adjudication procedures contradict Duke University policies, Duke University policies and procedures take precedence.

Early Career Program and 4+1 Program for Duke Students

Recent graduates of a Duke University bachelor's degree program can apply for the MEng Early Career Program up to five years after graduation. Admission must be approved by the department/program in which the master's degree is sought and by the Pratt School of Engineering. Recent graduates who have unused graduate-level (at the 500 level or above) elective credits as part of their undergraduate degree can generally transfer up to 4 courses into the MEng

program. Restrictions on the number of courses being transferred may apply depending on your prior academic program and your new academic program. Students enrolled in the Early Career Program will follow the standard application deadlines. Applicants are not required to take the GRE and are not charged an application fee.

Advanced Duke undergraduates may participate in a 4+1 Program where both a bachelor's degree and a MEng degree may be completed in five years. In the 4+1 Program, students may typically apply up to four graduate courses (at the 500 level or above) that were taken during their undergraduate career but not used to fulfill undergraduate degree requirements toward MEng degree requirements. Students on a case-by-case basis (such as AB Duke Scholarships that are available only to undergraduates) may be allowed to apply up to six courses.

To be considered for the 4+1 program, undergraduates may apply for a MEng admission decision during the standard admission cycle for entrance. Applicants are not required to take the GRE and are not charged an application fee. Students should consider the following guidelines when submitting materials:

- apply in the spring of the student's junior year for admission in the fall semester of the student's senior year; or
- apply in the fall of the student's senior year for admission in the spring semester of the student's senior year.

Admission decisions will be made and communicated to the student following the published admissions decision calendar. Although an admission decision may be made before or during the student's senior year, matriculation into the MEng Program will generally not occur until the undergraduate degree has been earned. Matriculation will occur in Summer Session 1 after the spring semester of the senior year unless a student opts for the 4+1 deferred enrollment option. Therefore, students will pay undergraduate tuition for the first four years of study and will pay MEng tuition for the fifth year of study. The 4+1 deferred enrollment option allows a student to defer enrollment for up to 3 years.

MEng courses are not typically available to undergraduates. After admission, 4+1 students work with the student records coordinator to register for MENG courses while an undergraduate. Not all graduate-level courses are available to undergraduates, and registration will only be provided for MENG courses. If a 4+1 student desires to take graduate-level elective classes that are not available to undergraduates, a 4+1 student should take these courses in the fifth year of study.

Generally, for graduate courses taken as an undergraduate to be transferred and counted toward the MEng degree:

- generally four graduate-level courses may be transferred to the MEng degree
- transferred courses may not have been used to fulfill any undergraduate degree requirements
- transferred courses must fulfill MEng degree requirements in the major of interest
- a grade of B or better must have been earned in the course.

To transfer course credit, an Early Career Program or 4+1 student should complete the Pratt Credit Transfer Form and obtain approval from the associate dean for undergraduate studies in the Pratt School of Engineering or the student's academic dean in the Trinity College of Arts & Sciences and the DMS for the student's MEng degree. Please note that the undergraduate course credits transfer to the MEng degree, but the grade earned will remain part of the student's undergraduate GPA and will not be used to calculate a MEng GPA.

For 4+1 students in the Trinity College of Arts & Sciences, preparation for success in a graduate engineering program may require that additional undergraduate courses must be taken as prerequisites. These prerequisite courses would be in addition to the 30 course credits required for the MEng degree. It is suggested that 4+1 students discuss their program of study with the DMS to understand the expectations in earning the degree. Depending on the extent of the prerequisite courses required, it may not be possible to complete the MEng degree in only one additional year.

Extra Courses/Semesters at Duke

The MEng degree can be earned in one to two years. Full-time students will typically take 9.0 to 12.0 course credits per semester. Students who desire to take 15.0 or more course credits in a semester should seek the approval of the DMS. For full-time students, the degree should be completed in no more than two years. Students are charged on a per-semester basis; however, students in their fourth semester may elect to be charged on a per-unit basis if they wish to take fewer than 10.0 credits.

Full-time versus Part-time

To be considered a full-time student, students must be registered for at least three graduate-level courses (9.0 course credits). Enrolling in fewer than three courses (9.0 credits) is considered part-time. International students must be enrolled full-time to maintain a valid visa with the exception of their final semester if their degree will be completed at the end of that semester. MEng students in their final semester must register for at least 1.0 tuition-bearing graduate-level unit (this does not include MENG 550, 551, or 552, GSPS Communication courses, or Career Design and Strategy (EGR 590-1), in addition to any courses required for graduation. This 1.0 tuition-bearing course may be outside of the student's program, but must be related to their degree. If a student is unable to find a 1.0 credit course due to their limited offerings, a 3.0 credit course should be taken.

Grading Policies

Standard Courses: A=Exceptional; B=Good; C=Satisfactory; (A, B, and C grades may include + or -); F=Failure; I=Incomplete; N=No Grade Given; W=Withdraw; Z= Satisfactory Completion of the first term of a two-course sequence

Audits: AD=Audit; WA=Withdrawal Audit; N=No Grade Report

Credit/No Credit (including Internship Courses): CR= Passing; NC=Failure

Incomplete Grades

Incomplete grades are to be assigned if, because of illness or other extenuating circumstances, a student's work in the course is incomplete. Students should make arrangements with their course instructor prior to the end of the semester if they anticipate that their work will be incomplete, and should work with their instructor to develop a plan for completing the work. Students who are given an incomplete must complete the work within one year, including any time on a leave of absence, or the I grade will become permanent.

Graduation

It is each student's responsibility to ensure that they have completed requirements for graduation, including the timely submission of the graduation application on DukeHub. A list of requirements is outlined below. Graduation will be delayed if a student does not complete all requirements within the required time frame.

MEng students in all disciplines must complete at least 30.0 course credits composed of key program elements, as follows:

- Core industry preparatory courses (6.0 course credits)
    - MENG 570 (Business Fundamentals for Engineers)
    - MENG 540 (Management of High Tech Industries)
- Departmental or interdisciplinary core courses (15.0 to 18.0 graduate course credits, varies by program)
- Technical electives in a concentrated area (6.0 to 9.0 graduate course credits, varies by program)
- Internship, Project, or Equivalent and Project Assessment
    - Internship Track
        - MENG 550 (Master of Engineering Internship/Project)
        - MENG 551 (Master of Engineering Internship/Project Assessment)
    - Co-op Program
        - EGRCOOP 501 (Engineering Graduate Cooperative Education 1)
        - MENG 551 (Master of Engineering Internship/Project Assessment)

Additional Graduation Requirements

- International students who are required to complete English language communication courses as determined by the Graduate Student Programs and Services are required to earn credit for the required courses as a graduation requirement. There are no tuition charges for these courses.
- Some departments require the one-credit, intensive Career Design and Strategy course (EGR 590-1) as a degree requirement. There are no tuition charges for this course.

International students should ensure that their intended graduation date is consistent with their visa status (see the Duke Visa Services Office website, visaservices.duke.edu).

Immunization Requirements

North Carolina State Law (General Statutes §130A 152–157) requires that all students entering college present a certificate of immunization that documents that the student has received all immunizations required by law. While your state or country of origin may have different immunization requirements, you must comply with North Carolina laws and Duke requirements. Entering students must present proof of immunizations to Student Health Services prior to the student's first day of class. Failure to comply with the State of NC and Duke University Immunization Requirements will result in the deactivation of your DukeCard. Your registrar will be notified and you will not be able to attend class or register for future classes. More information about the immunization requirements can be found at studentaffairs.duke.edu/studenthealth/immunization-compliance.

Independent Studies

Independent studies can be an effective tool for custom plans of study. However, they should not be overused or used to avoid more structured plans of study. Students may take up to two independent study courses as technical electives for their degree. An instructor and a DMS from the student's major must approve all independent studies.

Internships

Internships are meant to provide an applied experience for the MEng student. Responsibility for finding an internship lies with each student. The Career Center offers resources to facilitate successful searches including resume reviews and interview practice. Different disciplines may have somewhat different requirements or suggestions regarding the internship; thus, students should check with their discipline to ensure they are fulfilling specific discipline requirements.

Learning Objectives

- Apply engineering principles to solving one or more problems outside of the classroom environment.
- Define a problem and determine potential solutions.
- Appreciate the importance of organizational dynamics and work relationships.

- Practice professional communication in two forms: written and oral.
- Complement the material presented in the courses of the MEng degree program.
- Practice self-assessment.

Implementation Guidelines

- General Guidelines
    - The internship is a zero-credit course, but a course number (MENG 550) is provided to enable a simple way to track fulfillment of the requirement.
    - The minimum hourly requirement for the internship is 320 hours (eight weeks, forty hours per week).
- Internship Types
    - The internship can be a paid or unpaid experience, including a company or government summer job.
    - Internships in research labs are acceptable if the major allows such experiences and they meet the learning objectives.
    - International internships are encouraged as long as they meet the learning objectives.
    - Part-time internships are acceptable as long as they meet the minimum hourly requirement and the learning objectives.
    - Internships before the student receives a bachelor's degree will generally not be allowable as a MEng internship unless the student is enrolled in a concurrent bachelor's/MEng Program.
    - Guidelines on what constitutes an acceptable internship will be provided to all students, including the learning objectives and templates of the completion requirements.
    - Some programs will accept a project or an applied research experience in lieu of an internship experience. Students who wish to complete a project or applied research experience should contact the DMS for additional information.
- Completion Requirements
    - Successful completion of the internship will be verified by the DMS/program for each discipline and will include a written and/or oral project report (implementation will be determined by each discipline, examples include: poster session, oral presentation, project report, sponsor verification, etc.).
    - Upon completion of the internship, all MEng students will fill out a common form for their file, which includes information such as the participating organization, the activities undertaken, the dates of the internship, the title of the position, and the contact information of the student's supervisor.
    - Students must also enroll in MENG 551 in which they will write a report about their internship experience and complete a final presentation summarizing the experience.

Leave of Absence

The MEng Program is designed to accommodate both part-time and full-time students. It is generally expected that continuous enrollment will be the norm for MEng students regardless of their status as part-time or full-time. That is, for full-time students, continuous enrollment of three or more courses per semester, and for part-time students, continuous enrollment of one or more courses per semester is generally expected. Students who do not enroll in courses during the fall or spring semester may be contacted by their program to explain their program enrollment intentions. If the student is unresponsive to the program after multiple attempts at contact, they may, at the discretion of the associate dean for master's programs, be placed on an administrative leave of absence.

It is understood that circumstances and personal situations may sometimes require that students interrupt their education for some period of time. The deadline for a leave of absence is the last day of classes in a semester and is not typically granted once classes have ended and final exams have begun. All leave of absence forms (personal, medical, and academic) can be found on the Graduate Student Programs and Services website under Academic Resources.

A personal leave of absence is appropriate if a student has a personal situation to address away from school.

A medical leave of absence should be considered if, due to physical or mental health problems, continuing in courses is impossible for a student. A letter from the student's medical provider may be required to grant a medical leave of absence.

Except in unusual circumstances, a leave of absence of one or two years will be granted. A leave of absence greater than two years is generally not allowed. A student will need to begin the MEng Program again if a leave of absence greater than two years has occurred. The directors of the MEng Program may make exceptions to this general rule.

After a leave of absence, students must reapply and admission is not guaranteed. Students must complete the application and include an explanation of the circumstances surrounding the withdrawal, along with a statement describing the withdrawal and their reflections during their time away from Duke.

Foreign national students who wish to work in the United States after graduating need to understand the laws and policies regarding a leave of absence and the requirements upon readmission. Returning from a leave of absence greater than five months will require the student to reapply for their F-1 visa prior to entering the United States and returning to the program at Duke University. Additionally, work authorization laws set forth by the United States Department of Homeland Security require foreign national students to have been pursuing their degrees as full-time students for at least one academic year, two consecutive semesters not including the summer term, to be eligible for either Curricular Practical Training or Optional Practical Training. Therefore, foreign national students returning from a leave of absence must complete two consecutive semesters of full-time course work, regardless of how many credits they have completed toward the master of engineering degree.

Nondegree Option

Students who do not intend to obtain a MEng degree but are interested in some of the MEng courses may take them (i.e., courses designated as MENG) as a nondegree student. Nondegree status is distinct from MEng student status. Thus, if a student decides to become a part-time or full-time MEng degree student, a separate application and processing fee are required, and applicants must adhere to our standard admissions deadlines. A maximum of four MENG courses taken as a nondegree student may be applied to the Master of Engineering Program if the student is admitted. Only classes where the student earned a B or better are eligible to be transferred to the degree program. Note that tuition for these courses is paid separately from any other programs in which a student is currently enrolled. A nondegree student may be withdrawn from the active status if they have not taken a course for a period of three consecutive academic years. If withdrawn, the student will need to reapply to the program in order to take classes.

Non-MEng Student Registration

Graduate and professional students who are not enrolled in the Master of Engineering Program may register for some master of engineering courses (i.e., courses designated with MENG course numbers) on a space-available basis and with permission of the instructor. Instructors will require students to have sufficient background for the course as needed and may also limit outside enrollment for any pedagogical reason. Students who enroll in MEng courses as non-MEng students may not utilize these courses for a MEng degree if they have been used to satisfy coursework requirements for another degree at Duke.

For non-MEng students enrolling in MEng courses, no additional fees beyond their degree program fees will be charged by the MEng Program.

Regrading an Assignment, Exam, or a Course

Grading is up to the individual faculty member in each course; however, there are some general comments that apply to most courses. Most of the questions received after grading an exam or the entire course are very reasonable and well thought out. However, some indicate that it is necessary to reiterate the philosophy on grades:

- The only reason for a grade to change is if the faculty member made a mistake. This means that students must persuade the faculty member that a mistake has been made.
- This type of persuasion does not generally start with “I want...,” “I need...,” or even “the company I work for requires...”
- As students in an academic program that includes management and business training, students must take into account the manager’s (i.e., faculty member’s) perspective of fairness for the entire class. Please do not ask a faculty member to do something that is not fair for the entire class if they were in the faculty position.

If a student believes a mistake was made on their exams or final course grade, they are encouraged to speak to the professor. The addition of points, transcription of points from the assignments to the grade book, etc. are all possible sources of error. Answering questions from a particular reading or resource that the instructor did not have in mind when the question was written may also be a source of grading error. A clear and logical argument for such mistakes should be easy to make. If a student is struggling simply to improve their grade then it is likely they should not be requesting the regrading. If a student has evidence that a mistake was made in their grading and the instructor of the course does not consider this evidence the student should discuss the situation with the DMS.

Additionally, if a student is interviewing with companies that have a threshold of some minimum GPA and they are struggling to meet that minimum threshold, then perhaps the student is interviewing with the wrong companies. Generally, these same companies will ignore GPA in three years if the student can convey a record of accomplishments. If a student is on the borderline of GPA acceptability, then they are urged to consider changing their strategy of either which companies they would like to work for or how and when they plan to work for them. In those exceptional cases where a problem remains unresolved through discussions with the professor and the DMS, an appeal may be made by following the process in the Appeals section of the Bulletin under "Appealing an Academic-, Conduct- or Complaint-Related Decision". Any appeal must be made in writing and must include a description of the error that was made in assigning a grade.

Retention of Examinations

Instructors are requested to retain all final examination papers for at least one year after the date the examination is given. Examination papers should be available for reference when a final grade is questioned.

Transferring Policies

Transferring Credits from Non-Pratt PhD Programs at Duke University

If a student has completed the preliminary exams for their PhD outside of a Pratt School of Engineering Department at Duke University, they will be allowed to waive up to two courses in the MEng Program if at least two courses taken for their PhD fulfill requirements for the MEng major of interest. Thus, a student can receive the MEng degree by completing eight additional courses and the internship/project/equivalent requirement. Admission to the MEng Program is separate from admission to the student’s PhD program.

Transferring Credits from The Fuqua School of Business into the MEng Program

If a student has completed the Fuqua MBA course requirements, they will be allowed to waive the two core industry prep courses in the MEng Program. Thus, a student can receive the MEng degree by completing eight additional courses, the internship/ project/equivalent requirement. Admission to the MEng Program is separate from admission to The Fuqua School of Business.

Transferring Credits from Other Universities

The MEng degree program requires the successful completion of ten courses (30.0 credits) at Duke. Curricula meeting MEng degree requirements are specified by the student's MEng degree program and in consultation with the DMS of that program. If a student has taken graduate courses at another university that were not used for that degree, these courses may be used to fulfill course requirements (but not credit requirements) for the Duke MEng degree. Otherwise, the transfer of credits for courses from other universities is not allowed, unless under the terms of an external agreement, as described below.

Duke University or the Pratt School of Engineering may enter into external agreements, similar to the interinstitutional agreement, with local North Carolina Universities that allow courses taken at other universities to count toward the degree. For more information, visit registrar.duke.edu/registration/interinstitutional-registration/duke-students-visiting-other-campuses.

In general, under such agreements, courses that transfer should be taken after matriculation to Duke University. A maximum of 4 courses (12.0 credits) may transfer. Additionally, students transferring credits from other universities must complete at least 6 courses (18.0 credits) through Duke University.

Prior to registering for any non-Duke course to be applied to the MEng degree, students must obtain course-transfer approval from the DMS and a faculty member whose teaching relates to the technical area of the course.

Students may be required to pay a study abroad fee for the semester away from Duke.

Transferring Between Pratt's Professional Master's Programs and/or The Graduate School

Currently enrolled students may transfer between Pratt's Professional Master's programs and/or the Pratt Graduate School Master's programs in limited circumstances at the completion of the first, typically fall, semester of their original program with the approval of the original program, the new program, the Assoc. Dean for Pratt Master's Programs and The Graduate School (if applicable).

Information on transfers, including transfer request deadlines, can be found on the Pratt Graduate Student Programs and Services website under Academic Resources. Students must maintain a cumulative GPA of at least 3.0 and be in good academic and disciplinary standing to be approved for a program transfer. Generally, courses completed in the original program that fulfill the requirements of the new program will be transferred to the new program and will count toward the new program grade point average.

Transfer Options:

- MS/PhD to MEng or MEMP
- MEng/MEMP to MS
- Between MEng disciplines
- Between MEMP and MEng
- Between MS disciplines (reach out to The Graduate School for more information)

Transferring between MEng Program and MEng Online

Students must be approved to transfer between the campus MEng Program and the MEng Online Programs offered in the Artificial Intelligence for Product Innovation, Cybersecurity, and Financial Technology disciplines. The MEng Online degree is designed as a separate program distinctly targeted to working professionals with industry experience. Only on an exceptional basis for compelling reasons will a student be allowed this option. The student must meet with and be approved by the DMS for the online program. Similarly, MEng Online students wanting to transfer to the campus MEng Program must meet with and be approved by the DMS for the campus MEng Program.

Undergraduate-Level Courses

Courses below the graduate level, typically below the 500 level, may not be applied toward the required credits needed for the MEng degree. With the approval of the instructor of the undergraduate course, the director of master's studies, and the associate dean for master's programs, students may enroll in lower-level courses, but these courses will not count toward any graduation requirement and will not be included in a student's GPA calculation.

Withdrawal, Involuntary Administrative

The Vice Provost/Vice President for Student Affairs or designee may take administrative action(s) against a student and/or a student group to protect the health, safety, or welfare of the university community or any member of it. Administrative action includes, but is not limited to, a "no contact" directive, removal of privileges (including access to campus property and/or participation in remote/virtual campus programs), removal from or relocation within the residential community, suspension of activity, and/or suspension from the university. If administrative action is issued while a disciplinary action is pending, such action may remain in effect until the disciplinary process is resolved.

Procedure

- Any member of the university community who has reason to believe that a student or student group may pose a threat to the health, safety, or welfare of the university community or any member of it should contact the Vice Provost/Vice President for Student Affairs (VPSA) or other staff within Student Affairs as appropriate.
- The VPSA or designee, in consultation as necessary with the Behavioral Assessment Team and/or other appropriate individuals/agencies, will conduct a review of available information and, where necessary and appropriate, gather additional information.

- Based on the available information, the VPSA or designee shall determine whether administrative action is warranted based on the nature of the risk posed by the student, the probability of harm to the university community, and whether reasonable alternatives would significantly mitigate the risk. The VPSA or designee will prepare a written statement identifying and explaining the administrative action(s).
- A student who is subject to an administrative action has three business days from receipt of the written statement to request a meeting with the VPSA or designee to contest the administrative action. Based on the information shared by the student in the meeting, the VPSA or designee shall consider whether any modification to the administrative action is warranted and communicate the decision to the student in writing no later than three days after the meeting. The administrative action may be, at the discretion of the VPSA or designee and subject to the risk determinations as noted above, in force through the period of requested reconsideration of the administrative decision.

Master of Engineering in Artificial Intelligence for Product Innovation

Program Code: E-EGR-AIPI
Degree Designation: Master of Engineering
Department: Institute for Enterprise Engineering
Website: masters.pratt.duke.edu/ai

Program Summary

Students in the MEng Artificial Intelligence for Product Innovation On-Campus Program develop strong technical skills in Artificial Intelligence together with an understanding of software product design and development. After graduation, students are well-equipped to build AI-based products and systems within large companies or through their own entrepreneurial ventures. Graduates go on to work in leading companies solving difficult problems across many industries, such as tech, healthcare, energy, retail, transportation and finance.

Through the program, students will learn to:

- Identify and assess opportunities for the application of AI/ML in products
- Design data pipelines and ML systems for scale, security and usability
- Apply traditional ML and deep learning models to solve challenging problems across domains
- Build full-stack software applications integrating machine learning models utilizing the latest methods and technologies

Innovative and immersive, this on-campus master's degree can be completed in 12 or 16 months.

View Master of Engineering overview and academic policies.

Admissions Policies & Practices

The Duke Artificial Intelligence for Product Innovation Master of Engineering (MEng) is designed to be accessible to participants from a variety of engineering and science backgrounds.

Applicants should have:

- An undergraduate degree in science or engineering (or equivalent technical work experience if your degree is in a non-technical field)
- Proficiency in one or more programming languages (Python preferred)
- Sufficient DUOLINGO, IELTS, or TOEFL English Language Testing scores (official results required; international students only)
- Two (2) semesters of calculus

Prior coursework in probability and statistics and linear algebra is highly encouraged, but not required for admission.

MD/MEng in Engineering Program (School of Medicine)

This five-year program is designed for MD candidates who wish to also obtain a Master of Engineering (MEng) degree. In brief, students spend four years (Years 1, 2, 4 and 5) in medical school to fulfill the MD curriculum requirements, and one year (Year 3) to take the required MEng courses detailed below. In the fourth year, students work on development of new technologies or engineering approaches (including optimization/system analysis or feasibility analysis, etc.) for improving healthcare, improving public health, or reducing health hazards and write a thesis, for which they will receive School of Medicine credit in fulfillment of their Third Year thesis requirement.

Additional academic policies for the MD/MEng in Engineering program can be found at medicine.bulletins.duke.edu/som-programs/dr/md#dual-degree-programs1.

Class Attendance Policy for On-Campus AI MEng Students

On-campus AI MEng students are expected to attend class regularly and in person, adhering to the Graduate dates within Duke's Academic Calendar when applicable.

It is critical that students attend the first day and the last day of class for all courses in which they are enrolled, as well as all applicable Orientation programming for new students in August.

At the conclusion of the first class of each course, faculty will report any unexcused absences to the AI MEng program administration. Those students may then be dropped from the course at the program director's discretion.

Note that instructors may have additional attendance guidelines for their class that you must follow that go beyond the baseline of this attendance policy. Please refer to each course's syllabus for more specific information regarding individual professors' attendance policies.

A student seeking an "excused" absence must work directly with her or his course faculty (or the program director and master's coordinator in the case of Orientation programming). Students must initiate the request in advance and as soon as possible.

A student may be excused from attendance due to truly extenuating circumstances such as significant illness, personal/family emergency, or important religious observance.

Whether an absence is excused or not, a student will be held fully accountable for any in-class graded participation or assignments an absence caused the student to miss.

Academic Requirements

- **Bootcamp and Career Strategy (2 courses)**
  - AIPI 503
  - EGR 590-1
- **Technical Core (5 courses)**
  - AIPI 501
  - AIPI 510
  - AIPI 520
  - AIPI 540
  - AIPI 561
- **Product Development Core (3 courses)**
  - MENG 540
  - MENG 570
  - AIPI 560
- **Industry Project (1 course)**
  - AIPI 549
- **Internship/Project and Assessment (2 courses)**
  - MENG 550
  - MENG 551
- **AI Departmental Electives (3 courses)**
  - Any 3 courses AIPI 510-590L
- **Technical Electives (6 credits)**
  - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Artificial Intelligence for Product Innovation—Online

Program Code: E-EGR-AIPO
Degree Designation: Master of Engineering
Department: Institute for Enterprise Engineering
Website: masters.pratt.duke.edu/ai

Program Summary

Students in the MEng Artificial Intelligence for Product Innovation Online Program develop strong technical skills in Artificial Intelligence together with an understanding of software product design and development. After graduation students are well-equipped to build AI-based products and systems within large companies or through their own entrepreneurial ventures. Graduates go on to work in leading companies solving difficult problems across many industries, such as tech, healthcare, energy, retail, transportation and finance.

Through the program, students will learn to:

- Identify and assess opportunities for the application of AI/ML in products
- Design data pipelines and ML systems for scale, security and usability
- Apply traditional ML and deep learning models to solve challenging problems across domains
- Build full-stack software applications integrating machine learning models utilizing the latest methods and technologies

Innovative and immersive, this master's degree can be completed online part-time in just 24 months.

View Master of Engineering overview and academic policies.

Admissions Policies & Practices

The Duke Artificial Intelligence for Product Innovation Master of Engineering (MEng) is designed to be accessible to participants from a variety of engineering and science backgrounds.

Applicants should have:

- An undergraduate degree in science or engineering (or equivalent technical work experience if your degree is in a non-technical field), *and*
- Proficiency in one or more programming languages (Python preferred), *and*
- Sufficient DUOLINGO, IELTS, or TOEFL English Language Testing scores (official results required; international students only), *and*
- Two (2) semesters of calculus

Prior coursework in probability and statistics and linear algebra is highly encouraged, but not required for admission.

Academic Requirements

- **Pre-Program Bootcamp (1 course)**
  - AIPI 503
- **Technical Core (5 courses)**
  - AIPI 501
  - AIPI 510
  - AIPI 520
  - AIPI 540
  - AIPI 561
- **Product Development Core (3 courses)**
  - MENG 540
  - MENG 570
  - AIPI 560
- **Internship/Project and Assessment (2 courses)**
  - MENG 550
  - MENG 551
- **AI Departmental Electives (6 credits)**
  - Any 6 credits from AIPI 510-590
- **Technical Electives (6 credits)**
  - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Residency (2 courses)**
  - AIPI 504
  - AIPI 505

Master of Engineering in Biomedical Engineering

Program Code: E-EGR-BME
Degree Designation: Master of Engineering
Department: Biomedical Engineering Department
Website: bme.duke.edu/masters/degrees/meng-bme

Program Summary

The 30-credit Duke Master of Engineering in Biomedical Engineering provides a unique combination of opportunities:

- A respected and highly-ranked graduate program
- Engineering and business courses plus an internship
- Access to graduate certificate programs in high-demand career areas
- Dedicated career support
- A track record of positive career outcomes

View Master of Engineering overview and academic policies.

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
  - MENG 540
  - MENG 570 (BME 590 may also count)
- **Internship/Project and Assessment (3 courses)**
  - EGR 590-1

    - MENG 550
    - MENG 551
- **Departmental Requirements (5 courses)**
    - 1 Advanced Mathematics Course
    - 1 Life Science Course
    - 3 BME Technical Courses
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Electives (9 credits)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Civil Engineering

Program Code: E-EGR-CE
Degree Designation: Master of Engineering
Department: Civil & Environmental Engineering Department
Website: cee.duke.edu/grad/masters#meng

Program Summary

Duke's Master of Engineering (MEng) in Civil Engineering is a career-focused degree option that will deepen your understanding of technology and help you develop the business leadership and management expertise you need to succeed in your career.

View Master of Engineering overview and academic policies.

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
    - MENG 540
    - MENG 570
- **Internship/Project and Assessment (2 courses)**
    - MENG 550
    - MENG 551
- **Seminar (1 course)**
    - CEE 701
    - CEE 702
- **Choose 1 Concentration (6 credits)**
    - 6 credits in one of the following concentrations: Computational Engineering, Geo-Systems, Systems Engineering and Optimization
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Departmental Requirements (12 credits)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Electives (6 credits)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Climate and Sustainability Engineering

Program Code: E-EGR-CSE
Degree Designation: Master of Engineering
Department: Civil & Environmental Engineering Department
Website: cee.duke.edu/grad/masters/meng-climate-sustainability

Program Summary

The effects of climate change are impossible to ignore. But even armed with a science or engineering degree, the path to making an impact isn't a straight one. Impactful solutions require leaders who are comfortable working with uncertainty, evaluating risk, iterating a solution to better meet user needs, considering unintended consequences and anticipating future changes.

Duke's Master of Engineering in Climate and Sustainability Engineering is designed to create such holistic leaders. Through our specialized curriculum, you will strengthen and grow your technical analysis and design skills as applied to dynamic, real-world climate change challenges. Our program builds expertise beyond traditional engineering subject matter, preparing professionals who are ready to implement nimble solutions for a rapidly changing landscape.

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
    - MENG 540

    - MENG 570
- **Internship/Project and Assessment (2 courses)**
    - MENG 550
    - MENG 551
- **Seminar (1 course)**
    - CEE 690 Climate and Sustainability Engineering Seminar
- **Departmental Requirements (complete 12 credits)**
    - CEE 690 Applied Climate and Sustainability Engineering
    - Systems Engineering for Climate Response Modeling
    - CEE 690 Material Design in a Circular Economy
    - Energy Transition
    - Risk and Resilience Engineering
    - Sustainable Business for Engineers
- **Electives (6 credits)**
    - At least 6 elective credits approved by the department, or Design Climate I (3) and Design Climate II (3)

As this is a new program, these requirements are being developed and students should direct questions to the program director.

Master of Engineering in Computational Mechanics and Scientific Computing

Program Code: E-EGR-CMSC
Degree Designation: Master of Engineering
Department: Engineering Management Program
Website: cee.duke.edu/grad/masters/meng-computational-mechanics

Program Summary

Duke's Master of Engineering in Computational Mechanics and Scientific Computing is one of the most comprehensive in the world—and features a top-notch faculty.

Increasingly, engineering systems are being designed and tested virtually. The successful use of model-based simulation in modern applications requires a solid background in engineering physics, computer science, probability, data sciences, and applied mathematics. This Master of Engineering program provides a strong foundation in all of these areas.

The program emphasizes the use and development of modern numerical tools for model-based simulations such as finite element methods, uncertainty quantification procedures, and data analysis techniques, among others.

We offer a large number of core and elective courses in finite element methods for applications in solid mechanics, fluid mechanics, and coupled field problems.

In the Duke Master of Engineering program, you take specialized technical classes and a core of business leadership and management courses, with a required internship or a project to complete the degree.

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
    - MENG 540
    - MENG 570
- **Internship/ Project and Assessment (2 courses)**
    - MENG 550
    - MENG 551
- **Finite Element Methods (2 courses)**
    - CEE 530/ME 524
    - CEE 630/ME 525
- **Applied Math/Statistics (1 course)**
    - MATH 541
    - MATH 551
    - MATH 561
- **Computer Science (1 course)**
    - ECE 551D
    - COMPSCI 590 (PARALLEL COMPUTING)

- **Concentration Requirements (4 courses)**
    - 1 Fluid Mechanics course
    - 1 Mechanics of Materials course
    - 1 Optimization/Data Analytics course
    - 1 additional course
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Cybersecurity

Program Code: E-EGR-CYBS
Degree Designation: Master of Engineering
Department: Institute for Enterprise Engineering
Website: masters.pratt.duke.edu/cybersecurity

Program Summary

Cybersecurity is an engineering discipline focused on the protection of computer systems from malicious intrusion, damage, or disruption of the critical services those systems provide provide.

Duke's Master of Engineering in Cybersecurity provides the latest knowledge and skills in the practice of cybersecurity—with a focus on developing leaders and management for corporate, academic, and public sector cybersecurity teams.

Full-time/on-campus typically finish in 3 semesters and still maintain their life and work priorities.

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
    - MENG 540
    - MENG 570
- **Internship/Project and Assessment (2 courses)**
    - MENG 550
    - MENG 551
- **Technical Core (4 courses)**
    - CYBERSEC 500
    - CYBERSEC 501
    - CYBERSEC 590
    - CYBERSEC 503
- **Electives (5 courses)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Cybersecurity—Online

Program Code: E-EGR-CYBO
Degree Designation: Master of Engineering
Department: Institute for Enterprise Engineering
Website: masters.pratt.duke.edu/cybersecurity

Program Summary

Cybersecurity is an engineering discipline focused on the protection of computer systems from malicious intrusion, damage, or disruption of the critical services those systems provide provide.

Duke's Master of Engineering in Cybersecurity provides the latest knowledge and skills in the practice of cybersecurity—with a focus on developing leaders and management for corporate, academic, and public sector cybersecurity teams.

Part-time/online students typically finish 5 semesters and still maintain their life and work priorities.

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
    - MENG 540
    - MENG 570
- **Internship/Project and Assessment (2 courses)**
    - MENG 550
    - MENG 551

- **Technical Core (3 courses)**
    - CYBERSEC 500
    - CYBERSEC 590
    - CYBERSEC 503
- **Residency (1 course)**
    - CYBERSEC 504
    - CYBERSEC 505
    - CYBERSEC 506
- **Electives (5 courses)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Design and Technology Innovation

Program Code: E-EGR-DT
Degree Designation: Master of Engineering
Department: Institute for Enterprise Engineering
Website: masters.pratt.duke.edu/design-technology-innovation

Program Summary

The integration of design, technology and business and social innovation is essential to driving positive future change. The Design & Technology Innovation Master of Engineering degree helps students develop skills to lead and deliver design- and technology-driven impact in any organization.

Our students will shape how we engage with the next generation of technology and learn design how to design for tomorrow's challenges today.

The degree can be completed full-time on-campus in 3 semesters.

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
    - MENG 540
    - MENG 570
- **Internship/Project and Assessment (2 courses)**
    - MENG 550
    - MENG 551
- **Departmental Requirements (2 courses)**
    - DESIGNTK 501S
    - EGR 590-1
- **Technical Core (6 courses)**
    - 3 Design Innovation Methods courses: DESIGNTK 520, 521, and 522
    - 2 Design Technology courses: DESIGNTK 530 and 531
    - 1 Design Ethics & Social Innovation course: DESIGNTK 540
- **Electives (2 courses)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Electrical and Computer Engineering

Program Code: E-EGR-ECE
Degree Designation: Master of Engineering
Department: Electrical & Computer Engineering
Website: ece.duke.edu/masters/degrees/meng

Program Summary

The Duke ECE Master of Engineering degree provides a unique combination of advantages:

- **Interdisciplinary training** that develops technical knowledge plus business skills
- **Flexible curriculum** oriented around high-demand fields
- **Industry internship** plus professional development support
- **Excellent career outcomes**, and a global alumni network

Academic Requirements

At least 30 credits total to complete the degree.

- **Core (2 courses)**
  - MENG 540
  - MENG 570
- **Internship/Project (2 courses)**
  - MENG 550
  - MENG 551
- **Required Course (1 course)**
  - ECE 701S
- **Choose 1 Curricular Track (8 courses)**
  - **Computer Hardware Engineering Track**
    - 2 Computer Architecture courses
    - 1 Applications of Hardware course
    - 2 Hardware/Software Interface courses
    - 2 Digital System Design courses
    - 1 Programming course
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
  - **Machine Learning/Big Data Track**
    - ECE 580
    - ECE 581
    - ECE 586
    - ECE 590D (PROGRAMMING & DS FOR ML)
    - ECE 590 (DATA ENGINEERING)
    - 3 additional courses
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
  - **Quantum Hardware/Software Track**
    - 2 Quantum Core courses
    - 2 Software courses
    - 2 Hardware courses
    - 1 Quantum Elective course
    - 1 additional course
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
  - **Software Engineering Track**
    - 2 Core courses: ECE 551D/751D and ECE 651
    - 1 Computer Architecture course
    - 2 Systems courses
    - 2 Computing Elective courses
    - 1 additional course
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
  - **Semiconductor Technology Track**
    - 2 Fundamental Science courses
    - 2 Devices courses
    - 2 Circuits courses
    - 2 additional courses
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Electrical and Computer Engineering—Duke Kunshan University

Program Code: K-EGR-ECE
Degree Designation: Master of Engineering
Department: Electrical & Computer Engineering Department
Website: ece.dukekunshan.edu.cn

Program Summary

Duke Kunshan University (DKU) is a partnership of Duke University and Wuhan University to create a world-class university offering a range of academic programs and conferences for students from China and throughout the world. Duke Kunshan University is located in Kunshan, Jiangsu province, China. Located near both Shanghai and Suzhou, and connected to both by high- speed rail, the city of Kunshan is a center for business and has been one of the fastest growing economies in China.

This two-year master's degree program is built upon Duke's Master of Engineering Program in electrical and computer engineering. This program was designed with Chinese industrial needs in mind—exposing students to US-style education as well as modern Chinese industry practices and industry standards. Seeking to develop tech leaders with a global perspective, the program affords students the opportunity to learn business and industrial management fundamentals, as well as core engineering skills. The curriculum as a whole is designed to develop engineers who have the knowledge, leadership skills, and creative problem-solving abilities necessary to thrive in the global tech sector.

Students enrolled in the two-year program will spend their first year at Duke Kunshan University and their second year at Duke in the Pratt School of Engineering. Upon graduation, students will receive a Duke Master of Engineering degree and become alumni of both Duke University and Duke Kunshan University.

Master of Engineering DKU students will be able to participate in the Cooperative Education Program offered to residential Master of Engineering students. Students can review information about the Cooperative Education Program in the Master of Engineering Academic Policies section of the bulletin for more information.

Academic Requirements

Minimum of 10 Graduate Level Courses Required + ECE 701 Seminar

- **Software Engineering Track**
  - Core: Programming / Software Engineering (2 courses):
    - ECE 551DK: Programming, Data Structures, and Algorithms in C++ - Required, Year 1, Fall semester
    - ECE 651K: Software Engineering - Required, Year 1, Spring semester
  - Computer Architecture (1 course):
    - ECE 550DK: Fundamentals of Computer Systems and Engineering – Required, Year 1, Fall semester
  - Systems (2 courses):
    - ECE 650K: Systems Programming and Engineering – Required, Year 1, Spring semester
    - Selected from Duke course list – Required, Year 2
  - Computing (2 courses):
    - Selected from Duke course list – Required, Year 2
    - Selected from Duke course list – Required, Year 2
  - Electives (1 course):
    - Selected from Duke course list – Required, Year 2
  - General Requirements (All Students):
    - MENG 540 Management of High Tech Industries – Required, Year 2
    - MENG 570 Business Fundamentals for Engineers – Required, Year 2
    - MENG 550K Master of Engineering Internship/Project – Required, Summer Term/ Not counted toward 10-course requirement
    - MENG 551 Master of Engineering Internship/Project Assessment – Required, Year 2/ Not counted toward 10-course requirement
    - ECE 701SK ECE Masters Success Seminar – Required, Year 1 / Not counted toward 10-course requirement
    - GS 720K Academic Writing – Required, Year 1, Fall semester / Not counted toward 10-course requirement
    - GS 721K Academic Communication Skills– Required, Year 1, Spring semester / Not counted toward 10-course requirement

- **Machine Learning/Big Data Track**
  - Programming (1 course)
    - ECE 590K Programming and Data Structures for Machine Learning – Required, Year 1, Fall semester
  - Machine Learning (2 courses)
    - ECE 590K Machematics for Machine Leaning – Required, Year 1, Fall semester

        - ECE 590K – Practical Machine Learning – Required, Year 1, Spring semester
    - Deep Learning (1 course)
        - ECE 590K Deep Learning – Required, Year 1, Spring semester
    - Data Engineering (1 course)
        - ECE 590DE Data Engineering – Required, Year 2
    - ML/BD Electives (2 courses)
        - Selected from Duke course list – Required, Year 2
        - Selected from Duke course list – Required, Year 2
    - Electives (1 course):
        - Selected from Duke course list – Required, Year 2
    - General Requirements (All Students):
        - MENG 540 Management of High Tech Industries – Required, Year 2
        - MENG 570 Business Fundamentals for Engineers – Required, Year 2
        - MENG 550K Master of Engineering Internship/Project – Required, Summer Term/ Not counted toward 10-course requirement
        - MENG 551 Master of Engineering Internship/Project Assessment – Required, Year 2/ Not counted toward 10-course requirement
        - ECE 701SK ECE Masters Success Seminar – Required, Year 1 / Not counted toward 10-course requirement
        - GS 720K Academic Writing – Required, Year 1, Fall semester / Not counted toward 10-course requirement
        - GS 721K Academic Communication Skills– Required, Year 1, Spring semester / Not counted toward 10-course requirement

Master of Engineering in Environmental Engineering

Program Code: E-EGR-ENV
Degree Designation: Master of Engineering
Department: Civil & Environmental Engineering
Website: cee.duke.edu/grad/masters#meng

Program Summary

The challenge of sustainable environmental quality requires innovative thinking, clear leadership, and strong technical expertise. Duke's Master of Engineering in Environmental Engineering is ranked a Top 15 program in the United States. We will give you the comprehensive training you need to become a leader in protecting natural resources. Our program draws from Duke's Pratt School of Engineering and Nicholas School of the Environment—so you get the best of our renowned engineering and environmental research community. Coursework draws on recent research by our world-class faculty, many of whom are involved in major federally-funded research centers such as the Superfund Research Center at Duke.

Specializations include:

- Environmental Data Science
- Environmental Engineering and Public Policy
- Environmental Health Engineering
- Hydrology & Environmental Fluid Dynamics

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
    - MENG 540
    - MENG 570
- **Internship/Project and Assessment (2 courses)**
    - MENG 550
    - MENG 551
- **Seminar (1 course)**
    - CEE 701
    - CEE 702
- **Departmental Requirements (5 courses)**
    - Choose 5 of the following:
        - 1 Applied Mathematics, Statistics, and Data Science course
        - 1 Atmospheric and Hydrologic Processes course
        - 1 Biosciences course
        - 1 Chemistry course
        - 1 Engineered Systems course
        - 1 Transport Processes and Modeling course

    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Electives (9 credits)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Financial Technology

Program Code: E-EGR-FNTK
Degree Designation: Master of Engineering
Department: Institute for Enterprise Engineering
Website: masters.pratt.duke.edu/fintech/degree/

Program Summary

Financial technology, or FinTech, describes the innovative applications of computer software and networks, and other information technology, on financial institutions and markets. This includes technology enabling digital currencies (such as cryptocurrencies), digital assets, financial process automation, wealth management and trading, robotic advising, payment and transactions, financial data analysis, credit and lending, and much more.

Learn financial technologies and how to apply them—including computing fundamentals, blockchain, digital wallets, cryptocurrency, and smart contracts. Our master's students also take courses that build their management and communications skills— for a full professional degree.

The degree can be completed full-time on-campus in 3 semesters.

Class Attendance Policy for On-Campus FinTech MEng Students

On-campus FinTech MEng students are expected to attend class regularly and in person, adhering to the Graduate dates within Duke's Academic Calendar when applicable. It is critical that students attend the first day and the last day of class for all courses in which they are enrolled, as well as all applicable Orientation programming for new students in August. Note that instructors may have additional attendance guidelines for their class that you must follow that go beyond the baseline of this attendance policy. Please refer to each course's syllabus for more specific information regarding individual professors' attendance policies.

A student seeking an "excused" absence must work directly with her or his course faculty (or the program director and master's coordinator in the case of Orientation programming). Students must initiate the request in advance and as soon as possible. A student may be excused from attendance due to truly extenuating circumstances such as significant illness, personal/family emergency, or important religious observance. Whether an absence is excused or not, a student will be held fully accountable for any in-class graded participation or assignments an absence caused the student to miss.

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
    - MENG 540
    - MENG 570
- **Internship/Project and Assessment (2 courses)**
    - MENG 550
    - MENG 551
- **Technical Core (5 courses)**
    - FINTECH 501
    - FINTECH 510
    - FINTECH 512
    - FINTECH 520
    - FINTECH 522
- **Capstone (1 course)**
    - FINTECH 502
- **Electives (9 credits)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Financial Technology—Online

Program Code: E-EGR-FNTO
Degree Designation: Master of Engineering
Department: Institute for Enterprise Engineering
Website: masters.pratt.duke.edu/fintech/degree/

Program Summary

Financial technology, or FinTech, describes the innovative applications of computer software and networks, and other information technology, on financial institutions and markets. This includes technology enabling digital currencies (such as cryptocurrencies), digital assets, financial process automation, wealth management and trading, robotic advising, payment and transactions, financial data analysis, credit and lending, and much more.

Learn financial technologies and how to apply them—including computing fundamentals, blockchain, digital wallets, cryptocurrency, and smart contracts. Our master's students also take courses that build their management and communications skills — for a full professional degree.

The degree can be completed online part-time in 5 semesters.

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
  - MENG 540
  - MENG 570
- **Internship/Project and Assessment (2 courses)**
  - MENG 550
  - MENG 551
- **Residency (1 course)**
  - FINTECH 505
- **Technical Core (5 courses)**
  - FINTECH 501
  - FINTECH 510
  - FINTECH 512
  - FINTECH 520
  - FINTECH 522
- **Capstone (1 course)**
  - FINTECH 502
- **Electives (9 credits):**
  - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Game Design, Development, and Innovation

Program Code: E-EGR-GAME
Degree Designation: Master of Engineering
Department: Institute for Enterprise Engineering
Website: masters.pratt.duke.edu/gddi

Program Summary

Students in the Game Design, Development & Innovation (GDDI) MEng program develop strong technical the skills game industry leaders are looking for, such as proficiency in programming—including C# and C++—and how to apply these skills to the leading game engines. Students also learn design principles for gameplay, art, user experience and storytelling.

Our program seeks to use game design and development beyond entertainment. In addition to working on entertainment games, students also apply game development and game design in innovative ways to other applications such as education, medicine, and training simulations.

The program replicates a game studio environment where students work on a robust game project over two years - from ideation to publishing. Students must work as part of a team with other students to jointly develop these game(s) during the course of the Program and must sign the Student Game Agreement at the time the team is formed.

Curriculum Overview

The Game Design, Development & Innovation MEng's core curriculum is centered around the start-to-end publishing of a game in small groups over two years. As conveyed in the offer of admission, students must sign the Student Game Agreement at the time their teams are formed.

Students focus on their core programming and game development courses in the first year of the program. If a student demonstrates exceptional mastery of the curriculum's core content during their first fall term, they may be allowed to take an additional elective during their first spring term at the program director's discretion.

In the second fall term of the program, students are encouraged to take optional electives in addition to their two required electives. In the final spring term, students will go through the final steps to publish their game(s) in GAMEDSGN 589: Game Development Capstone.

Due to the unique nature and pacing of this program and its core game project, the two-year track cannot be significantly accelerated or altered.

Admissions Policies & Practices

The Duke Game Design, Development & Innovation MEng program is designed to be accessible to participants from a variety of engineering and science backgrounds. Applicants should have:

- An undergraduate degree in science or engineering (or equivalent technical work experience if your degree is in a non-technical field), *and*
- A minimum of one (1) semester of programming (any language), *and*
- Sufficient DUOLINGO, IELTS, or TOEFL English Language Testing scores (official result required; international students only)

Prior coursework in probability and statistics and linear algebra is highly encouraged, but not required for admission.

GDDI Professionalism Community Standard

The GDDI program's top priority is to graduate well-rounded, mature working professionals. This includes building strong technical skills, but it also includes how students show up as a professional, both on campus and in the workforce.

Our view of professionalism emphasizes:

- Treating others with respect.
- Fostering inclusion and belonging in the GDDI community, the Duke community, and the wider community.
- Communicating and collaborating openly and authentically with others.
- Contributing with good effort and good faith to team endeavors.
- Being punctual and attending all class meetings, team meetings, Orientation programming, etc.
- Following Pratt's current academic integrity policies and the Duke Community Standard.

Start and end dates for classes, as well as the dates for Orientation programming, are defined in the Pratt Academic Calendar. Please refer to individual course syllabi for more specific information regarding individual professors' attendance policies.

Academic Requirements

- **Pre-Program Bootcamp (optional)**
  - GAMEDSGN 503
- **Game Design Core Courses (6 courses)**
  - GAMEDSGN 510
  - GAMEDSGN 511
  - GAMEDSGN 520
  - GAMEDSGN 521
  - GAMEDSGN 530
  - GAMEDSGN 589
- **Business Core Courses (2 courses)**
  - MENG 540
  - MENG 570
- **Internship/Project and Assessment (2 courses)**
  - MENG 550
  - MENG 551
- **Career Strategy and Design Course (1 course)**
  - EGR 590
- **Technical Electives (6 credits)**
  - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Recommended Course Progression

Students are strongly encouraged to take as many GAMEDSGN electives as possible during the fall term of their second year:

- *First Fall Term:*
  - GAMEDSGN 510 Programming for Game Development (3 credits)
  - GAMEDSGN 520 Fundamentals of Game Development (3 credits)
  - GAMEDSGN 530 Critical Analysis of Video Games (3 credits)
  - EGR 590 Career Strategy and Design (1 non-tuition-bearing credits)
- *First Spring Term:*
  - GAMEDSGN 511 Software Engineering & Systems for Game Development (3 credits)
  - GAMEDSGN 521 Advanced Game Development (3 credits)
  - MENG 540 Management of High Tech Industries (3 credits)
- *First Summer Term:*
  - MENG 550 Master of Engineering Internship/Project (0 credits)

    - MENG 551 Master of Engineering Internship/Project Assessment (0 credits)
- *Second Fall Term:*
    - MENG 570 Business Fundamentals for Engineers (3 credits)
    - Technical Elective 1 (3 credits)
    - Technical Elective 2 (3 credits)
    - OPTIONAL: Technical Elective 3 (3 credits)
    - OPTIONAL: Technical Elective 4 (3 credits)
- *Second Spring Term:*
    - GAMEDSGN 589 Game Development Capstone (3 credits)
    - OPTIONAL: EGR 591 Career Strategy and Design II (1 non-tuition-bearing credits)

Master of Engineering in Materials Science and Engineering

Program Code: E-EGR-MSE
Degree Designation: Master of Engineering
Department: Mechanical Engineering and Materials Science
Website: dmi.duke.edu/degrees/masters

Program Summary

The Master of Engineering (MEng) in Materials Science and Engineering is an advanced engineering degree that includes business courses, technical training, and an internship.

Academic Requirements

At least 30 credits total to complete the degree.

- **Core Industry Preparatory Courses (2 courses)**
    - MENG 540
    - MENG 570
- **Internship/Project and Assessment (2 courses)**
    - MENG 550
    - MENG 551
- **Multi-Scale, Advanced, and Bio-Inspired Materials (3 courses)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Mathematics (1 course)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Electives (3 courses)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Mechanical Engineering

Program Code: E-EGR-ME
Degree Designation: Master of Engineering
Department: Mechanical Engineering and Materials Science
Website: mems.duke.edu/masters/degrees/meng

Program Summary

The Duke MEMS Master of Engineering degree provides a unique combination of advantages that only Duke can offer:

- **Interdisciplinary training** in engineering, science, and management
- **Flexible, individualized curriculum** combined with a required industry internship
- **Three-semester study plans** without a thesis
- **Excellent career outcomes** in the industry

The Duke Master of Engineering includes a flexible curriculum of engineering, science, and business training over three semesters—about 1.5 years:

- Get rigorous training while developing an engineering specialty of your design
- Business courses are enhanced by an internship with a leading company

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
    - MENG 540

    - MENG 570
- **Internship/Project and Assessment (2 courses)**
    - MENG 550
    - MENG 551
- **Specialty Requirement (12 credits)**
    - Complete 12 credits in 1 of the following specialties:
        - Autonomous, Intelligent Systems & Machines
        - Energy, Propulsion, & Structures for Earth & Space
        - Optimal Design for Virtual & Physical Systems
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Mathematics (3 credits)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Electives (9 credits)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Medical Technology Design

Program Code: E-EGR-MTD
Degree Designation: Master of Engineering
Department: Biomedical Engineering Department
Website: bme.duke.edu/masters/degrees/medtech-design

Program Summary

The market for medical devices worldwide is growing fast. In the United States alone, the MedTech industry is growing by an average of US$7 billion a year. Few universities are as uniquely equipped as Duke to deliver best-in-class master's-level training in medical technology design.

Academic Requirements

- **Skills Sequence (2 courses)**
    - BME 673L
    - BME 590L (topic: MEDICAL ELECTRICAL EQUIPMENT)
- **Design Health Sequence (3 courses)**
    - BME 773L
    - BME 774L
    - BME 775L
- **Business and Management (2 courses)**
    - BME 590 (topic: BUSINESS IN BME)
    - BME 590 (topic: QUALITY SYSTEMS FOR BME)
    - MENG 540
- **Elective Requirements (2 courses)**
    - 1 Advanced Math course
    - 1 Life Science course
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Internship Courses (3 courses)**
    - EGR 590-1
    - MENG 550
    - MENG 551

Master of Engineering in Photonics and Optical Sciences

Program Code: E-EGR-POS
Degree Designation: Master of Engineering
Department: Engineering Program
Website: meng.pratt.duke.edu/disciplines/photonics

Program Summary

Duke's Master of Engineering (MEng) in Photonics and Optical Sciences is an alternative to a traditional master of science program that will deepen your understanding of technology and help you develop the business leadership and management expertise you need to succeed in your career. In the Master of Engineering program, you take specialized technical classes and a core of business leadership and management courses, with a required internship or a project completing the degree.

Duke is home to the Fitzpatrick Institute for Photonics (FIP), where researchers are making strides across many areas of photonics and optical science—including making scalable quantum computing a reality, helping doctors do a better job of eradicating cancer, and developing the next generation of high-throughput imaging systems. The research of the FIP faculty is reflected in the courses offered through our Master of Engineering in Photonics and Optical Sciences.

Master of Engineering students train with the very best people in the optics field, and pair that classroom experience with an understanding of core business principles. Our graduates have the technical savvy to move discoveries forward and the business skills to shepherd important advances to realization.

The exceptional resources available through the Fitzpatrick Institute, the Corporate Partnership Program, and the Carolinas Photonics Consortium make Duke a great choice for graduate studies in photonics and optical sciences.

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
  - MENG 540
  - MENG 570
- **Internship/Project and Assessment (2 courses)**
  - MENG 550
  - MENG 551
- **Departmental Requirements (3 courses)**
  - 1 Advanced Mathematics course
  - 2 Optics/Photonics courses
  - 2 Technical Optics/Photonics courses
  - A comprehensive list of courses is available to students on the program webpage and the Stellic degree audit site.
- **Technical Electives (3 courses)**
  - 1 BME or ECE Course
  - 2 Technical Engineering courses
  - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Risk Engineering

Program Code: E-EGR-RE
Degree Designation: Master of Engineering
Department: Civil & Environmental Engineering
Website: cee.duke.edu/grad/masters/meng-risk

Program Summary

Mitigating losses and human impacts to a range of extreme events, including financial, public health, environmental, and climatological crises is far more cost-effective than paying for recovery, remediation, and reconstruction.

Duke's Master of Engineering (MEng) in Risk Engineering emphasizes a systems approach and the use of statistical decision theory to assess the potential for extreme events, and the costs and benefits of their consequences.

Our students explore concentration areas including:

- Environment and Public Policy
- Materials and Structures
- Energy and Climate Systems

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
  - MENG 540
  - MENG 570
- **Internship/Project and Assessment (2 courses)**
  - MENG 550
  - MENG 551
- **Seminar (1 course)**
  - CEE 701
  - CEE 702
- **Uncertainty, Risk, and Systems Engineering Requirements (2 courses)**
  - CEE 690 (RISK AND RESILIENCE IN ENGR)
  - EGRMGMT 590 (SYSTEMS ENGINEERING)

- **Methodological Requirements (3 courses)**
    - Complete 1 course from 3 of the following areas:
        - Mathematical Modeling Optimization
        - Policy Analysis
        - Uncertainty Quantification and Data Analytics
        - Valuation, Assessment, and Decision Making
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Concentration Requirements (3 courses)**
    - Complete 3 courses from 1 of the following concentrations:
        - Energy and Climate Systems
        - Environment and Population Health
        - Materials and Structures
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering in Robotics and Autonomy

Program Code: E-EGR-ROBT
Degree Designation: Master of Engineering
Department: Mechanical Engineering & Materials Science Department
Website: mems.duke.edu/academics/masters/meng-robotics

Program Summary

Today, undergraduate experience in robotics isn't enough. This master's degree provides deep technical training in the disciplines that define the field—including mechanical design, machine learning and controls. Also, at Duke you'll gain the ethical insight and business training needed by a leader of a high-tech organization. All completed in just three semesters — no thesis required.

Academic Requirements

- **Core Industry Preparatory Courses (2 courses)**
    - MENG 540
    - MENG 570
- **Internship/Project and Assessment (2 courses)**
    - MENG 550
    - MENG 551
- **Robotics Core (2 courses)**
    - ME 555 (Introduction to Robotics)
    - ME 555 (Introduction to Programming)
    - COMPSCI 527
- **Department Requirements (4 courses)**
    - 1 Machine Learning course
    - 1 Controls & Dynamics course
    - 1 Ethics course
    - 1 Capstone course
    - A comprehensive list of courses is available to students on the program webpage and the Stellic degree audit site.
- **Electives (2 courses)**
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Master of Engineering Management

Program Code: E-MGT-MEG & E-MGT-DME
Degree Designation: Master of Engineering Management
Department: Institute for Enterprise Engineering
Website: memp.pratt.duke.edu/campus & memp.pratt.duke.edu/online

Program Summary

The Pratt School of Engineering at Duke University offers an interdisciplinary Master of Engineering Management (MEM) degree in cooperation with The Fuqua School of Business and the Duke University School of Law. Designed to develop engineering leaders of consequence for technology-based organizations, the degree provides a personalized, applied engineering management curriculum to a select group of high-potential students with science and engineering backgrounds.

Duke's MEM Program was launched in 1997 out of recognition that society needs engineers with business skills. This is consistent with current interest to develop "T-shaped" individuals with focused expertise in a technical area of interest (the stem of the T) and breadth of workplace skills, such as business acumen and leadership (the top of the T). To address complex societal grand challenges, it is imperative that engineers have the interdisciplinary perspective to understand not only technological challenges, but also the environmental, societal, and fiscal implications of engineering design decisions.

Duke offers an online education program for working professionals, known as the MEM Online Program. This program combines three week-long residencies with semester-based online coursework that allows students to work and attend school simultaneously. The online courses are accessible via the web and allow a student to participate synchronously or asynchronously according to their needs and schedule. In addition to the course content, these integrated courses allow students to learn effective skills for working productively with others from a distance.

In summary, Duke's interdisciplinary Master of Engineering Management Program produces leaders of consequence—graduates with "T-shaped" skill sets encompassing a solid business foundation and focused technical expertise. Perhaps more importantly, they have developed the ability to think critically and creatively, enabling them to use that expertise to make a profound impact on society.

The core of the Master of Engineering Management Program consists of four engineering management courses developed in conjunction with the Duke University School of Law and The Fuqua School of Business. A required internship accompanied by a written project summary and oral presentation ensures students have work experience, while four graduate-level technical courses of the student's choosing serve to extend the student's science and engineering background.

See Master of Engineering Management Academic Policies.

Master of Engineering Management Academic Policies

Academic Freedom

Freedom of inquiry and the free exchange of ideas are essential for the fulfillment of the university's mission. Academic freedom is a right and responsibility of students as well as faculty. Students who believe that their academic freedom has been abridged should submit a written complaint to the director of the MEM Program. The Executive Director of the MEM Program may enlist the Associate Dean for Faculty Affairs and Community Engagement to provide advice. Cases not resolved by the director of the MEM Program may be brought to the attention of the provost. Students may also seek advice of the student ombudsperson in resolving a complaint.

Academic Standing and Satisfactory Academic Progress

To maintain satisfactory academic progress (SAP), students must achieve a required minimum grade point average (GPA) of 3.0, complete two-thirds (67%) of cumulative attempted courses, and are limited to a maximum of 45.0 attempted credits. Attempted and completed courses include courses for which A-F letter grades or (CR) Credit/(NC) No Credit are assigned. Attempted but not completed courses include courses with grades of (I)ncomplete or (W)ithdrawn. Courses that are not counted in the attempted calculation include EGRCOOP, courses taken for audit and courses with grades of (Z) Continuing or (N)o grade given.

The short duration of the program means that these requirements must be taken very seriously by all students immediately upon entry into the program. Students who do not make satisfactory academic progress or who receive an F in any course may be subject to academic disciplinary action. These actions may include academic probation, suspension, or dismissal. Academic probation means that the student is in danger of being suspended or dismissed from the program. It also means that the student should take immediate action to be more successful academically. A variety of actions may be required when a student is placed on academic probation, including, but not limited to, tutoring, exclusion from extracurricular activities, enrollment in specific courses, and/or limiting the number of classes taken in a semester. In addition, students must have a grade point average of B (3.0) or better to graduate.

Suspension, dismissal, and graduation are authorized by the Associate Dean of Master's Programs. If the student believes the process failed to consider relevant information, violated fair procedures in some other way, or imposed consequences inappropriate to the offense, they may appeal the suspension, dismissal, or graduation decision within seven days by following the process in the Appeals section of the Bulletin under "Appealing an Academic-, Conduct- or Complaint-Related Decision".

Admission Revocation

The MEM Program reserves the right to rescind any applicant's admission to the program if new information arises pertaining to significant academic performance issues, criminal activity, Duke Community Standard violations, or other extraordinary circumstances. In general, significant issues that justify withdrawing an offer of admission would be those that could lead to a suspension or dismissal if a student were already enrolled in the MEM Program.

Decisions to revoke admissions will be made by the Associate Dean for Master's Education, and appeals may be made by following the process in the Appeals section of the Bulletin under "Appealing an Academic-, Conduct- or Complaint-Related Decision".

Career Strategy and Design Course (EGR 590-1)

Career Strategy and Design is a one-credit course designed to teach the principles of effective self-advocacy and ways to apply those in an active internship and job search. Students will identify their professional strengths and values, explore career paths of interest, and learn to articulate whether and how selected paths align. Students will finish the course with a powerful professional portfolio, including tailored job search materials, and an action plan for a successful job search.

The one-credit Career Design and Strategy course is a degree requirement for all MEM On-Campus students to help students build skills and confidence necessary to plan/execute their job search (internship or full-time).

Class Attendance Policy

MEM's policy is that campus students are expected to attend class regularly and in person, adhering to Duke's Academic Calendar. Attending MEM classes is mandatory. MEM follows the Graduate dates within the calendar when applicable.

It is especially important that students attend the first day and the last day of class for all courses in which they are enrolled. Unless and until all coursework and examinations (whether comprehensive final exams, quizzes, or otherwise) have been completed for all courses in which a student is enrolled, a student is expected to remain at Duke in person through the end of final exam week as set forth on Duke's Academic Calendar.

In their first classes, faculty set course goals and standards, frame the course's subject matter, form student teams, and begin to create the class community.

At the conclusion of the first class of each course, the faculty will report any unexcused absences to the MEM program administration. Thereafter, such students shall be dropped from the course. If students miss the first classes of the semester, they detract from their own educational experience and undermine that of their classmates. Furthermore, they create additional work for the professors and teaching assistants.

Responsibility for regular and punctual class attendance rests with individual students. The course faculty shall refer a student to MEM's administrators in the event of excessive absences.

A student seeking an "excused" absence must work directly with her or his course faculty and must initiate the request in advance and as soon as possible. A student may be excused from attendance due to truly extenuating circumstances such as significant illness, personal/family emergency, or important religious observance. Varsity athletes should submit a NOVAP (Notification of Varsity Athletic Participation) Form to each instructor whenever they are scheduled to miss a class because of athletic participation.

Whether an absence is excused or not, a student will be held fully accountable for any in-class graded participation or assignments an absence caused the student to miss.

Complaints

If a student has a concern with a course or with an aspect of the program, the concern should first be addressed to the faculty or staff member most associated with the area of concern. If the faculty or staff member is not able to address the concern, the matter may be brought to the attention of the MEM Program Director to address the situation. If a significant concern has not been addressed by the director, the matter may be appealed by following the process in the Appeals section of the Bulletin under "Appealing an Academic-, Conduct- or Complaint-Related Decision"

Cooperative Education Program

Residential students seeking to expand on the practical training component of their degree in a manner that more closely simulates life after school may participate in the Master of Engineering Management Co-op Program. This program will be one of two academic pathways students can follow to earn their degree:

- The traditional full-time program with an internship requirement, typically completed as full-time work during the summer with the option to work part-time during the school year, or
- The co-op program which will allow students to work full-time, away from Duke, during the school year, while remaining enrolled as a full-time student.

Once students have completed their first semester, they may explore employment opportunities with companies to participate in a co-op during the summer and/or fall terms and will present the opportunity they have identified to the Co-op Coordinator and their Faculty Advisor so that they may apply for the Co-op Program. To be eligible to participate in the co-op program, students must have a GPA of 3.0 or higher and be in good academic and disciplinary standing at the time they enroll in the Co-op Program. The typical co-op schedule will be to do at least an 8 week co-op in the summer and/or fall terms. Students may do both co-op sessions, return to campus the following spring semester to complete their coursework and graduate in May or graduate in the same term as their co-op, depending on the requirements of their program. Depending on work authorization requirements, other options may be available.

A co-op requires three party engagement with the Student, University Faculty, and a Company Sponsor. Both the Company and the Student will be required to sign documents that define the responsibilities and expectations of each party. As a result, there is more engagement with Duke University during a co-op than with a typical internship. Students will be expected to:

- Have monthly check-ins with their faculty advisor.
- Participate in a performance assessment with the sponsoring company, Faculty Advisor and Co-op Coordinator at least every 3 months of their co-op experience.
- Complete an employer's evaluation form to the Co-op Coordinator that assesses their co-op experience.

- Receive a job performance evaluation from the sponsoring company at the conclusion of the co-op experience that is shared with the Co-op coordinator and Faculty Advisor.

General Guidelines

- Co-op should be full-time work and take place at the employers' physical location or another approved company location, including remote work.
- The minimum hourly requirement for the co-op is 320 hours (eight weeks, forty hours per week).
- Students will enroll in a 9-credit co-op course (EGRCOOP 501, 502, or 503) to maintain their full-time status as a Duke student while they are not enrolled in other courses.
    - Tuition is not charged for this course, but there will be a $300 co-op fee charged per semester.
    - Students may enroll in up to three (3) co-op experiences (EGRCOOP 501, 502, and 503). Courses may not be repeated.
    - Participating in multiple co-op experiences may extend a student's program to a maximum of 33 months of visa approval. A maximum of 1 visa extension request may be made by a student.
    - Note: Students who use 12 months or more of full-time (20 or more hours per week) CPT will have no available time for Optional Practical Training (OPT).
- As tuition is not charged in the third term for Engineering Management students, this will apply to the semester the student returns to Duke and participates in traditional courses.
- For Engineering Management students, if students are using EGRCOOP 501 to satisfy the internship requirement, a maximum of 3 credits from co-op courses will be applied toward the 30-credit degree requirement.
- With approval of the Director of Master's Studies and the Sponsor Company, the student may take one academic class, under no circumstances to exceed 4 units, during their co-op semester. If the student will graduate during their co-op term, they may also enroll in EGRMGMT 551/MENG 551 along with the academic course. The student is responsible for the tuition for those classes at the per-credit tuition rate for their program, if applicable.
- Students may participate in a summer internship and then transition the position to a fall co-op once the required co-op paperwork has been completed. International students must apply for Curricular Practical Training (CPT) separately for the internship and co-op semesters.
- If a student is unable to complete their co-op or find another co-op opportunity, they will be returned to the standard internship pathway.
- Beginning in the Spring 2026 term, students participating in a co-op may not hold simultaneous campus employment at Duke University or the Pratt School of Engineering, e.g. as a Teaching Assistant.

Completion Requirements

- Successful completion of the co-op will be verified by the DMS/program for each discipline and will include a written and/or oral project report (implementation will be determined by each discipline, examples include: poster session, oral presentation, project report, sponsor verification, etc.).
- Students must also enroll in EGRMGMT 551 in which they will write a report about their internship experience and complete a final presentation summarizing the experience.

Course Enrollments and Registration

MEM courses generally follow the timeline for graduate student registration as designated by the University Registrar's Office and provided on the Pratt Academic Calendar found in the Bulletin. Students should be aware of course dates for courses outside of Pratt (Graduate School and undergraduate courses and courses at other schools) which can be found on the official Duke calendar (registrar.duke.edu/current-academic-calendar). Courses taken in The Fuqua School of Business follow the Fuqua School Daytime MBA calendar, which can be found on the Fuqua Daytime MBA website (fuqua.duke.edu/programs/daytime-mba/program-format). Fuqua operates on a term basis with two terms per semester; therefore, courses are compressed into an intense six-week schedule. The Academic Coordinator will send out detailed instructions about registration procedures via email.

Core Course Enrollments

Master of Engineering Management On-Campus Program

MEM On-Campus students complete core courses with their assigned cohorts. Students will be pre-enrolled in these courses.

Master of Engineering Management Online Program

Students in the MEM Online Program will register themselves for all courses. Registration instructions will be communicated via email from the Program Director or Academic Coordinator.

Core Course Exemptions (also known as Waivers)

A student may request an exemption from a core course if they have already taken a substantially similar course. Receiving an exemption does not decrease the number of courses that must be taken. The previously taken course will fulfill the degree requirements for the corresponding MEM core course, which allows the student to take one additional technical elective in its place.

In order for a course exemption to be considered, students must submit the syllabus for the previous course and the current MEM course, the student's transcript that includes the grade received for the previous course (should be a B or better), and the student's assessment of why the previous course and Duke's course are substantially similar. The exemption request should be made to the Executive Director of the MEM Program who will review the submitted materials and consult with the appropriate individual(s) before making a determination. All course exemptions are made on a case-by-case basis. A course with a title similar to a MEM core course is not sufficient justification for a course exemption. For the Course Waiver Application form and more information on the Course Waiver Policy, see the MEM Student Resources website.

Course Audits

Audits are permitted on a space-available basis with the consent of the instructor. Audit Permission Forms must be turned in by the last day of the Drop/Add period set forth by the registrar's office. Students may audit only one course per fall and spring semesters; no courses may be audited during the summer terms.

The fee for auditing a course depends on a student's tuition payment option. Degree students registered for regular MEM courses and who have selected the pay-by-semester payment option may audit a course without being charged. Degree students registered for regular MEM courses and who have selected the pay-by-unit payment option may audit a course but will incur an audit fee for each course audited. This policy is in effect for all students, even if a student decides to change from pay-by-semester to pay-by-unit in their last semester of the program.

It is important that students understand an instructor's expectations for auditing a course, such as completing assignments and readings, participating in class, etc. Auditing students must comply with these requests to successfully complete the audit, as it is possible to fail.

Generally, nondegree-seeking candidates may not audit or sit in on courses; however, alumni of the MEM Program, Post-docs, and students from MEM Program Consortium Schools who wish to audit a class for personal or professional development will be considered on a case-by-case basis.

The course audit request form and policy can be found on the MEM Student Resources Website under the Academics tab.

Course Enrollment at Fuqua

A few select Fuqua electives are open to full-time Duke graduate students with two caveats: (1) admission is strictly on a space-available basis, and (2) permission from the instructor is required. Note that students must have the proper background or prerequisites. Please note that not all Fuqua electives are approved as MEM technical electives. A list of approved MEM technical electives offered by Fuqua may be accessed on the MEM Student Resources website.

MEM students cannot directly enroll online and must comply with the Fuqua registration process and deadlines, which will be communicated via email by the Academic Coordinator. Please review the registration information provided in the MEM Academic Information folder under the MEM Student Resources website under the Academics tab. Online students cannot access Fuqua classes online. Fuqua MBA Core Courses are not open to non-Fuqua students.

Course Enrollment at Nearby Universities: Interinstitutional Enrollment

Under the interinstitutional registration agreement, any MEM student enrolled as a degree-seeking student at any of the following universities may take technical electives at the following universities:

- North Carolina Central University
- North Carolina State University
- The University of North Carolina at Chapel Hill
- The University of North Carolina at Charlotte
- The University of North Carolina at Greensboro

Permission of the MEM Program Director is required and students will be charged Duke University tuition rates for such courses. Distance courses may not be taken under an interinstitutional transfer agreement. More information about interinstitutional registration can be found on the university registrar's website at registrar.duke.edu/interinstitutional-duke-students-visiting-other-campuses.

MEM students are not permitted to take interinstitutional or non-EGRMGMT classes during the summer. Students are also not permitted to take interinstitutional classes in their final term as late grade submission may delay graduation.

Course Enrollment in Undergraduate Level Classes

Courses below the graduate level, typically below the 500 level, may not be applied toward the required credits needed for the MEM degree. With the approval of the instructor of the undergraduate course and the Executive Director of MEM, students may enroll in lower-level courses, but these courses will not count toward graduation credit requirements and will not be included in a student's MEM GPA calculation.

Course Withdrawal Policy

"Withdrawing" from a course is different from "dropping" a course. When you drop a course, you can do so yourself through DukeHub during the drop/add period. Courses dropped before the drop/add deadline will not appear on your transcript. (The Graduate School and The Fuqua School of Business set Drop/Add dates for their respective courses and those dates are followed accordingly.)

After the drop/add deadline has passed, Master of Engineering Management students must request a course withdrawal. The withdrawn course will appear on your permanent transcript as a withdrawal (W).

If the student decides to pursue a course withdrawal, they must obtain a signature from the instructor. The requirement for the instructor's signature provides an opportunity for the student to discuss the issues leading to the student's request and to determine whether the student is fully informed about performance, grading and readiness for the course. The signature also provides the mechanism by which instructors learn that the student will no longer be a member of the class.

The last day to withdraw from a course is the last day of classes for each semester. For more information or to request a course withdrawal, please visit the MEM Student Resources website under the Academics tab.

Dual-Degree and Joint Programs

Information about dual-degree options and joint programs is available at memp.pratt.duke.edu/campus/flexible-degree-options.

Duke University Policies

Policies that apply to all students at Duke University may be found at policies.duke.edu. In some cases, the Master of Engineering Management Program may have supplemental policies to Duke University Policies. If the Master of Engineering Management Program policies or adjudication procedures contradict Duke University Policies, Duke University Policies and procedures take precedence.

Early Career Program and 4+1 Program for Duke Students

Recent graduates of a Duke University bachelor's degree program can apply for the MEM Early Career Program up to five years after graduation. Admission must be approved by the MEM Program and by the Pratt School of Engineering. Recent graduates who have unused graduate-level (at the 500 level or above) elective credits as part of their undergraduate degree can transfer up to 4 courses into the MEM program.

Students enrolled in the Early Career Program will follow the standard application deadlines. Applicants are not required to take the GRE and are not charged an application fee. Students may request to transfer their admission to the MEM Online program.

Advanced Duke undergraduates may participate in a 4+1 Program where both a bachelor's degree and a MEM degree may be completed in 4.5 to 5 years. In the 4+1 Program, students may typically apply up to four graduate courses (at the 500 level or above) that were taken during their undergraduate career but not used to fulfill undergraduate degree requirements toward MEM degree requirements.

To be considered for the 4+1 Program, undergraduates may apply for MEM Program admission during the standard admission cycle for entrance. Applicants are not required to take the GRE and are not charged an application fee. Students should consider the following guidelines when submitting materials:

- apply in the spring of junior year for admission in the fall semester of the student's senior year; or
- apply in the fall of senior year for admission in the spring semester of the student's senior year.

Admission decisions will be made and communicated to the student following the published admissions decision calendar. Matriculation will typically occur in Summer Session 1 after the spring semester of the senior year unless a student opts for the 4+1 deferred enrollment option. Therefore, students will pay undergraduate tuition for the first four years of study and will pay MEM Program tuition for the fifth year of study. The 4+1 deferred enrollment option allows a student to defer enrollment for up to 3 years.

MEM courses are not typically available to undergraduates. After admission, 4+1 students work with the student records coordinator to register for EGRMGMT courses while an undergraduate. Not all graduate-level courses are available to undergraduates, and registration will only be provided for EGRMGMT courses.

Generally, for graduate courses taken as an undergraduate to be transferred and counted toward the MEM degree, the courses must meet the following conditions:

- a maximum of four courses may be transferred to the MEM degree;
- transferred courses may not have been used to fulfill any undergraduate degree requirements;
- transferred courses must fulfill MEM degree requirements; and
- a grade of B or better must have been earned in the course.

To transfer course credit, an Early Career Program or 4+1 student should complete the Pratt Credit Transfer Form and obtain approval from the associate dean for undergraduate studies in the Pratt School of Engineering or the student's academic dean in the Trinity College of Arts & Sciences and the executive director of the MEM Program. Please note that the undergraduate course credits transfer to the MEM degree, but the grade earned will remain part of the student's undergraduate GPA and will not be used to calculate a MEM GPA.

Duration of MEM Program

Master of Engineering Management On-Campus Program

Duke Master of Engineering Management (MEM) students can choose to graduate after 2, 3, or 4 semesters based on their career goals and plan. Students completing four classes per semester can complete the degree in as little as two semesters and an internship. Students completing three classes per semester can complete the degree in three semesters and an internship. Limitations on the number of additional courses/semesters are at the discretion of the Associate Dean and executive director of Professional Master's Programs in consultation with their program committee. Full-time students who begin the program in the fall, should complete the MEM degree in no more than 22 months.

Students are responsible for maintaining good academic standing (generally considered to be a B average); thus, they should consider this when determining the number of courses to take each semester. Students should note the Drop/Add deadline if considering dropping a course.

Master of Engineering Management Online Program

The online Master of Engineering Management degree generally can be earned in two to four years. Students completing two classes per semester can complete the degree in as little as two years. Students completing one class per semester can complete the degree in four years. Limitations on the number of additional courses/semesters are at the discretion of the Director of MEM Online Program. Students must pay at least the full tuition amount for the program prior to graduating. Students are responsible for maintaining good academic standing (generally considered to be a B average); thus, should consider this when determining the number of courses to take each semester.

Full-Time versus Part-Time

To be considered a full-time student, students must be registered for at least three graduate-level courses (9.0 course credits). Enrolling in fewer than three courses (9.0 credits) is considered part-time. International students must be enrolled full-time to maintain a valid visa with the exception of their final semester if their degree will be completed at the end of that semester. MEM students in their final semester must register for at least 3.0 tuition-bearing graduate-level units (this does not include EGRMGMT 550, 551, or 552, GSPS Communication Courses, or Career Design and Strategy (EGR 590-1), in addition to any courses required for graduation.

Grading

Standard Courses: A=Exceptional; B=Good; C=Satisfactory; (A, B, and C grades may include + or -); F=Failure; I=Incomplete; N=No Grade Given; W=Withdraw; Z= Satisfactory Completion of the first term of a two-course sequence

Audits: AD=Audit; WA=Withdrawal Audit; N=No Grade Report

Credit/No Credit (including Internship Courses): CR= Passing; NC=Failure

Incomplete Grades

Incomplete grades are to be assigned if, because of illness or other extenuating circumstances, a student's work in the course is incomplete. Students should make arrangements with their course instructor prior to the end of the semester if they anticipate that their work will be incomplete, and should work with their instructor to develop a plan for completing the work. Students who are given an incomplete must complete the work within one year, even if the student is on a leave of absence, or the I grade will become permanent.

Grade Disputes

Faculty/University policy stipulates that grade changes may only be requested due to computation or transcription errors. If a student believes a mistake was made on their exams or final course grade, they are encouraged to speak to the professor. If a student has evidence that a mistake was made in their grading and the instructor of the course does not consider this evidence the student should appeal this with the MEM Executive Director for their opinion. In cases where a problem remains unresolved through discussions with the professor or the program director, an appeal may be made by following the process in the Appeals section of the Bulletin under "Appealing an Academic-, Conduct- or Complaint-Related Decision".

Graduation Requirements

It is each student's responsibility to ensure that they have successfully completed all degree requirements for graduation, including the timely submission of the graduation application on DukeHub during the Apply for Graduation window. A list of requirements is outlined below. Graduation will be delayed if a student does not complete all requirements within the required time frame.

MEM Program graduation requirements are as follows:

- Four core management courses:
    - EGRMGMT 510 (Marketing)
    - EGRMGMT 520 (Intellectual Property, Business Law, and Entrepreneurship)
    - EGRMGMT 530 (Finance and Accounting for Technology-Based Companies)
    - EGRMGMT 540 (Management in High-Tech Industries)
- Four graduate-level technical elective courses, typically 500 level and above, chosen from:
    - departments within the Pratt School of Engineering, including engineering management electives
    - courses outside of the Pratt School of Engineering with the director's approval; and
    - courses at partnering universities through the Interinstitutional Registration Agreement, with the director's approval.
- Internship, written project summary, and oral presentation (EGRMGMT 550 and EGRMGMT 551)
- Career Design and Strategy (EGR 590-1: Special Topics: Career Design & Strategy)*
- Two semesters of the MEM Seminar and Workshop Series (EGRMGMT 501)**
- Complete the graduation application on DukeHub during the Apply for Graduation window. Failure to apply may delay graduation and/or the receipt of the student's diploma. (If, for any reason, a student needs to change their graduation date, they must contact the student records coordinator for approval.)

Additional Graduation Requirement: International students who are required to complete communication courses as determined by Graduate Student Programs and Services are required to earn credit for the required courses as a graduation requirement. There are no tuition charges for these courses.

*The one-credit, Career Design and Strategy course is a degree requirement for students matriculating in the MEM On-Campus Program beginning in the Fall 2023 semester. There are no tuition charges for this course.

**MEM Online students complete three residencies to fulfill the Seminar and Workshop Series requirement.

Students may track their degree progress and ensure they are fulfilling all degree requirements by logging into Stellic, an online degree auditing platform, using their NetID and password. International students should ensure that their intended graduation date is consistent with their visa status (see the Duke Visa Services Office website, visaservices.duke.edu).

Immunization Requirements

North Carolina State Law (General Statutes §130A 152–157) requires that all students entering college present a certificate of immunization that documents that the student has received all immunizations required by law. While a student's state or country of origin may have different immunization requirements, all students must comply with North Carolina laws and Duke requirements. Entering students must present proof of immunizations to Student Health Services prior to the student's first day of class. Failure to comply with the State of NC and Duke University Immunization Requirements will result in the deactivation of a student's DukeCard. A student's registrar will be notified and they will not be able to attend class or register for future classes. More information about the immunization requirements can be found at studentaffairs.duke.edu/studenthealth/immunization-compliance.

Independent Studies

Independent studies (EGRMGMT 591) are intended to be projects designed and initiated by students to pursue academic interests that are not covered in the standard course offerings. Once the student has determined the content and focus of an independent study, they must find an interested faculty member who is willing to serve as the instructor. The student and faculty member must submit The Independent Study Proposal form to the Executive Director of the MEM Program for final approval. Students may take up to two independent study courses as technical electives for their degree.

Leave of Absence

The MEM On-Campus and MEM Online programs are designed to accommodate both part-time and full-time students. It is generally expected that continuous enrollment will be the norm for all students regardless of their status as part-time or full-time. That is, for full-time MEM students, continuous enrollment of three or more courses per semester, and for part-time students, continuous enrollment of one or more courses per semester is generally expected. For MEM Online students, continuous enrollment of at least one course per semester is generally expected. Students who do not enroll in courses during the fall or spring semester may be contacted by their department to explain their program enrollment intentions. If the student is unresponsive to the program after multiple attempts at contact, they may, at the discretion of the Associate Dean for Master's Programs, be placed on an administrative leave of absence.

It is understood that circumstances and personal situations may sometimes require that students interrupt their education for some period of time. The deadline for a leave of absence is the last day of classes in the semester in which the leave is to begin. A leave of absence is not typically granted once classes have ended and final exams have begun. All leave of absence forms (personal, medical, and academic) can be found on the MEM Student Resources website under Academics, Policies, and Forms.

A personal leave of absence is appropriate if a student has a personal situation to address away from school.

A medical leave of absence should be considered if, due to physical or mental health problems, continuing in courses is impossible for a student. A letter from the student's medical provider may be required to grant a medical leave of absence.

Except in unusual circumstances, a leave of absence of one or two years will be granted. A leave of absence greater than two years is generally not allowed. A student will need to begin the MEM Program again if a leave of absence greater than two years has occurred. The director of the MEM Program may make exceptions to this general rule.

After a leave of absence, students must reapply and admission is not guaranteed. Students must complete the application and include an explanation of the circumstances surrounding the withdrawal, along with a statement describing the withdrawal and their reflections during their time away from Duke.

Foreign national students who wish to work in the United States after graduating need to understand the laws and policies regarding a leave of absence and the requirements upon readmission. Returning from a leave of absence greater than five months will require the student to reapply for their F-1 visa prior to entering the United States and returning to the program at Duke University. Additionally, work authorization laws set forth by the United States Department of Homeland Security require foreign national students to have maintained active status in their program of study for at least one academic year, two consecutive semesters not including the summer term, to be eligible for either Curricular Practical Training or Optional Practical Training. Therefore, foreign national students returning from a leave of absence must complete two consecutive semesters of coursework, regardless of how many credits they have completed toward the Master of Engineering Management degree.

Nondegree Option

Students who do not intend to obtain a MEM degree but are interested in some of the MEM courses may take MEM courses (i.e., courses designated as EGRMGMT) as a nondegree student. Nondegree status is distinct from MEM degree student status. Thus, if a student decides to become a part-time or full-time MEM degree student, a separate application and processing fee are required, and applicants must adhere to our standard admissions deadlines. A

maximum of four EGRMGMT courses taken as a nondegree student may be applied to the MEM degree program if the student is admitted. Only classes where the student earned a B or better are eligible to be transferred to the degree program. Note that tuition for these courses is paid separately from any other programs in which a student is currently enrolled. A nondegree student may be withdrawn from the active status if they have not taken a course for a period of three consecutive academic years. If withdrawn, the student will need to reapply to the program in order to take classes.

Non-MEM Student Registration

Graduate and professional students who are not enrolled in the MEM Program may register for some MEM courses (i.e., courses designated courses designated as EGRMGMT) on a space-available basis and with permission of the instructor. Instructors will require students to have sufficient background for the course as needed and may also limit outside enrollment for any pedagogical reason. For example, some courses require very close teamwork and thus may be hindered by allowing students outside of the MEM Program to enroll in the course. Generally, no more than five non-MEM students will be allowed to enroll in a course at any given time. Students who enroll in MEM courses as non-MEM students may not utilize these courses for an MEM degree. Generally, the MEM core courses are not available to non-MEM students. The core courses for the MEM Program are as follows:

- EGRMGMT 510 (Marketing)
- EGRMGMT 520 (Intellectual Property, Business Law, and Entrepreneurship)
- EGRMGMT 530 (Finance in High-Tech Industries)
- EGRMGMT 540 (Management of High-Tech Industries)

For non-MEM students enrolling in MEM courses, no additional fees beyond their degree program fees will be charged by the MEM Program. To enroll in a MEM course, the student must fill out the Non-MEM Student Course Registration Permission Form found on the MEM Student Resources website under Academics, Policies, and Forms.

Retention of Examinations

Instructors are requested to retain all final examination papers for at least one year after the date the examination is given. Examination papers should be available for reference when a final grade is questioned.

Seminar Series and Workshops

Through our weekly seminar and workshop series, MEM On-Campus students develop important professional skills. Course policies are outlined in the course syllabus, which is provided to students on the course's learning management platform site (such as Sakai or Canvas). Failing to follow course guidelines may result in unfulfilled requirements for the MEM On-Campus Program and thus can prevent a student from receiving their degree. All students must complete two semesters of the seminar workshop course before graduating with their MEM degree.

Part-time students must enroll in two semesters of the seminar course and attend the equivalent of two semesters of seminars and workshops during their enrollment in the program. Part-time students must consult with the EGRMGMT 501 instructor before the semester's Drop/Add period ends to discuss their involvement in the course.

MEM Online students complete three residencies to fulfill the Seminar and Workshop Series requirement.

Summer School

During the summer terms, no lecture style Engineering Management classes are offered. However, many Engineering Management students choose to fulfill their internship requirement during this time. The Academic Coordinator for each program will provide detailed instructions for the procedure to enroll in the required Internship courses: EGRMGMT 550: Engineering Management Internship and EGRMGMT 551: Engineering Management Internship Assessment. Foreign national students who are working on their internship in the United States during the summer will need to apply for Curricular Practical Training (CPT) and must enroll in EGRMGMT 550 over the summer. For more information about CPT, visit the Duke Visa Services website, visaservices.duke.edu.

MEM students cannot take summer classes outside of the MEM Program to count towards their degree, but may take courses for their personal development.

Transferring Policies

Transferring Credits from Other Pratt School Departments into the MEM Program in an Ad Hoc Joint Degree with the MEM Program

Students may utilize up to three graduate courses taken as an MS or PhD student in the Pratt School of Engineering as technical electives in the MEM Program. Generally, these courses should be taken concurrently with the MEM degree or within the previous four years. Thus, an MS or PhD student can receive the MEM degree by completing five additional courses, four of which are the core courses, the internship requirement, and the seminar series. Approval from the MEM Program Executive Director is required. Admission to the MEM Program is separate from admission to other graduate programs at the Pratt School of Engineering and the MEM courses are paid for separately from the student's MS or PhD graduate courses.

Generally, the credits to be used for both degrees will only be seen on the MS/PhD transcript and will count only toward the student's MS/PhD grade point average.

Students in dual degree programs will receive both degrees simultaneously. Students will not be permitted to receive one degree in a different term than the other, even if coursework for one of the degrees has been completed.

Transferring Credits from The Fuqua School of Business into an Ad Hoc Joint Degree with the MEM Program

If a student has completed the Fuqua MBA course requirements then they will be allowed to waive three of the core courses in the MEM Program: EGRMGMT 510 (Marketing), EGRMGMT 530 (Finance in High-Tech Industries), and EGRMGMT 540 (Management in High-Tech Industries). Thus, a student can receive the MEM degree by completing five additional courses, the internship requirement, the seminar series, and other miscellaneous required activities in the MEM Program. The five courses the student must complete include the required EGRMGMT 520 (Intellectual Property, Business Law, and Entrepreneurship) core course and four technical electives. Admission to the MEM Program is separate from admission to The Fuqua School of Business.

Transferring Credits from Other Universities

Transfer of credits for courses from other universities is not allowed. A total of 30.0 credits must be taken at Duke. If a student has taken graduate courses at another university that were not used for their degree, they may give the student a bit more leeway in the types of courses that can be taken at Duke but they do not decrease the total number.

Duke University or the Pratt School of Engineering may enter into external agreements, similar to the interinstitutional agreement, with local North Carolina Universities that allow courses taken at other universities to count toward the degree. For more information, visit registrar.duke.edu/registration/interinstitutional-registration/duke-students-visiting-other-campuses.

In general, under such agreements, courses that transfer should be taken after matriculation to Duke University. A maximum of 4 courses (12.0 credits) may transfer. Additionally, students transferring credits from other universities must complete at least 6 courses (18.0 credits) through Duke University. Prior to registering for any non-Duke course to be applied to the MEM degree, students must obtain course-transfer approval from the Executive Director of the MEM and a faculty member whose teaching relates to the technical area of the course. Students may be required to pay a study abroad fee for the semester away from Duke.

Transferring Credits from the Naval Nuclear Power Training Command

Students in the United States Navy, who have completed their Nuclear Power Training as Nuclear Navy Propulsion Officers, may transfer a maximum of six credit hours toward the Master of Engineering Management degree. These credits will be listed as Duke Equivalent courses with the grade 'TR.' In order to transfer Nuclear Power Training course credit, admitted students must submit their academic and Joint Services Transcripts to the academic coordinator after enrollment in the MEM Program. The academic coordinator will request that the registrar transfer 6.0 credits to the student's academic record.

Transferring from Other Pratt School Departments into the MEM Program

Students leaving an MEng, MS, or PhD program in the Pratt School of Engineering may utilize up to four graduate courses in that program taken toward their MEM degree. For MEng students, all grades will count toward the MEM GPA. For MS and PhD students, only the courses that are transferred will count toward the MEM GPA.

Generally, for graduate courses to be transferred and counted toward the MEM degree, the courses must meet the following conditions:

- transferred courses must fulfill MEM degree requirements; and
- a grade of B or better must have been earned in the course.

Information on transfers, including transfer request deadlines, can be found on the Pratt Graduate Student Programs and Services website under Academic Resources. Students must maintain a cumulative GPA of at least 3.0 and be in good academic and disciplinary standing to be approved for a program transfer. Generally, courses completed in the original program that fulfill the requirements of the new program will be transferred to the new program and will count toward the new program grade point average.

Transferring from Non-Pratt Duke Departments into the MEM Program

Students leaving a graduate degree program outside of the Pratt School of Engineering may utilize up to two graduate courses in that program taken toward their MEM degree. The courses that are transferred will count toward the MEM GPA.

Generally, for graduate courses to be transferred and counted toward the MEM degree, the courses must meet the following conditions:

- transferred courses must fulfill MEM degree requirements; and
- a grade of B or better must have been earned in the course.

To transfer course credit, matriculated students should complete the Pratt Credit Transfer Form which can be found on the MEM Student Resources website under Policies and Forms.

Transferring between MEM On-Campus and MEM Online Programs

Students must be approved to transfer between the MEM On-Campus Program and the MEM Online Program. The MEM Online degree is designed as a separate program distinctly targeted to working professionals with industry experience. Only on an exceptional basis for compelling reasons will a student be allowed this option. The student must meet with and be approved by the MEM Executive Director. Similarly, MEM Online students seeking transfer to the MEM On-Campus Program must meet with and be approved by the MEM Executive.

Withdrawal, Involuntary Administrative

The Vice Provost/Vice President for Student Affairs or designee may take administrative action(s) against a student and/or a student group to protect the health, safety, or welfare of the university community or any member of it. Administrative action includes, but is not limited to, a “no contact” directive, removal of privileges (including access to campus property and/or participation in remote/virtual campus programs), removal from or relocation within the residential community, suspension of activity, and/or suspension from the university. If administrative action is issued while a disciplinary action is pending, such action may remain in effect until the disciplinary process is resolved.

Procedure

- Any member of the university community who has reason to believe that a student or student group may pose a threat to the health, safety, or welfare of the university community or any member of it should contact the Vice Provost/Vice President for Student Affairs (VPSA) or other staff within Student Affairs as appropriate.
- The VPSA or designee, in consultation as necessary with the Behavioral Assessment Team and/or other appropriate individuals/agencies, will conduct a review of available information and, where necessary and appropriate, gather additional information.
- Based on the available information, the VPSA or designee shall determine whether administrative action is warranted based on the nature of the risk posed by the student, the probability of harm to the university community, and whether reasonable alternatives would significantly mitigate the risk. The VPSA or designee will prepare a written statement identifying and explaining the administrative action(s).
- A student who is subject to an administrative action has three business days from receipt of the written statement to request a meeting with the VPSA or designee to contest the administrative action. Based on the information shared by the student in the meeting, the VPSA or designee shall consider whether any modification to the administrative action is warranted and communicate the decision to the student in writing no later than three days after the meeting. The administrative action may be, at the discretion of the VPSA or designee and subject to the risk determinations as noted above, in force through the period of requested reconsideration of the administrative decision.

Master of Engineering Management (E-MGT)

MEM On-Campus Academic Requirements

- **Core Courses (4 courses)**
  - EGRMGMT 510
  - EGRMGMT 520
  - EGRMGMT 530
  - EGRMGMT 540
- **Engineering Management Seminar (2 courses)**
  - EGRMGMT 501, taken twice
- **Career Strategy and Design (1 course)**
  - EGR 590-1
- **GCIP English Language Courses (if applicable)**
- **Engineering Management Internship or Co-Op Track (2 courses)**
  - Internship Track: EGRMGMT 550 & 551
  - Co-op Program: EGRCOOP 501 & 551
- **Electives (12 credits)**
  - A comprehensive list of elective courses is available to students on the MEM internal website: sites.duke.edu/mgmt

Master of Engineering Management (E-MGT)

MEM Online Academic Requirements

- **Core Courses (4 courses)**
  - EGRMGMT 510
  - EGRMGMT 520
  - EGRMGMT 530
  - EGRMGMT 540
- **Residency (3 courses)**
  - EGRMGMT 504
  - EGRMGMT 505
  - EGRMGMT 506
- **Engineering Management Internship (2 courses)**
  - EGRMGMT 550
  - EGRMGMT 551
- **Electives (12 credits)**
  - A comprehensive list of elective courses is available to students on the MEM internal website: sites.duke.edu/mgmt

MEM Online Residency Information

MEM Online offers a unique blend of learning delivery. The program combines the flexibility of remote coursework with close interactions and support of a cohort and faculty. A key component of the success to building a community for each class is the residency program. Each MEM Online student is required to attend three on-campus residencies throughout the duration of the degree.

Residencies allow MEM Online cohorts to meet, interact, and bond, as well as learn valuable tools for successfully navigating the MEM Online delivery format. Being on campus enhances communication with professors and faculty, allowing the one-on-one personal interaction necessary to forge strong ties and relationships with mentors. Through residency roundtables and workshops, students build career development skills. Finally, social activities planned for these three weeklong stays provide a way to enjoy the camaraderie of classmates.

The MEM Online residencies fulfill the Seminar and Workshop Series requirements that residential MEM Program students are required to complete. Generally, students are expected to complete the residencies sequentially; however, the MEM Executive Director may make exceptions for students with extenuating circumstances. These cases are rare and are considered on a case-by-case basis. For students that transition between the residential MEM Program and MEM Online, the MEM Executive Director may approve a blended combination of residencies and EGRMGMT 501 to fulfill this degree requirement.

Registration for residencies is performed along with course registration through DukeHub. Failure to register for and/or attend a residency may delay graduation.

Residency 1: Orientation Residency

One week prior to the start of classes in Fall Year 1

This residency initiates the MEM Online Program. Program introductions and updates are delivered, expectations are outlined, and students have the opportunity to experience the Duke community. Highlights include distance technology/tooling overviews, workshops, faculty interaction, and social activities for MEM Online cohorts.

Residency 2: Mid-Program Residency

One week in July between Years 1 and 2

This residency provides students an opportunity to reconnect personally with faculty and cohorts. Seminars and workshops focusing on professional development and business simulation activities will be required to supplement the remote classroom experience. Social activities will further enhance relationship building amongst distance cohorts.

Residency 3: Capstone Residency

One week prior to May graduation in Spring Year 2

The culmination of the MEM Online Program, this residency provides students the forum for final class presentations and assessments. Interactions, discussions, and feedback mark the integration of learning and application. Social activities during this residency will bring cohorts together for a final shared experience. Students participate in Duke's graduation ceremonies alongside campus students.

Concurrent Graduate Certificates

The Pratt School of Engineering offers rigorous standalone and concurrent graduate certificate programs that recognize students for work in leading-edge areas of multidisciplinary research. These certificate programs provide graduate students with advanced training in interdisciplinary or emerging fields of knowledge.

- Aerospace
- AI for Materials (aiM)
- Biomedical Data Science
- Biotechnology
- Computational and Digital Health
- Medical Device Design
- Medical Robotics and Surgical Technologies
- Neural Engineering
- Robotics and Automation

Concurrent certificates are not standalone and cannot be earned independent of the student's degree. A student must be enrolled in a graduate degree program prior to enrolling in a certificate program. If a student completes the concurrent certificate's requirements, it will only be awarded when the primary graduate degree is also completed. A concurrent certificate will not be awarded if the student does not complete their primary graduate degree, even in the case that the certificate's requirements have been met. Students do not incur additional tuition or fees for a concurrent certificate program. The student's official Duke University transcript will note the certificate.

Additional information regarding application processes and curriculum requirements for each certificate program is available at pratt.duke.edu/grad/phd/certificates-training.

Aerospace Certificate

Program Code: E-AEROSP-C
Degree Designation: Certificate
Department: Mechanical Engineering
Website: mems.duke.edu/masters/certificates/aerospace

Program Summary

Professor Kenneth C. Hall, Director of Certificate Program, Julian Francis Abele Distinguished Professor of Mechanical Engineering and Materials Science

The Department of Mechanical Engineering and Materials Science offers the Studies and Opportunities in Aerospace Research (SOAR) graduate certificate. Students in MEMS graduate programs can expand their learning experience through this certificate. In research groups and courses, the program educates future leaders in engineering to enable the development of high-performance and ultra-efficient aircraft, including drones and UAVs. Reduced emissions, noise, and vibration are also important goals for the program's team. The globally recognized faculty within the SOAR certificate program are experts in structures and dynamics, aerodynamics, acoustics, and mathematical and computational methods. This certificate is open to students in the MEMS Master of Engineering (MEng), Master of Science (MS), or PhD programs.

Eligibility

Pratt MEMS MS, MEng, and PhD students. Students should declare they will be part of this certificate program in their first semester. After enrollment, students will be assigned an aerospace research advisor.

Academic Requirements

- **Focus Areas (2 courses)**
  - Complete 2 courses from either of the following focus areas:
  - Aerodynamics and Acoustics
    - ME 571
    - ME 572
    - ME 672
  - Structures and Dynamics
    - ME 524
    - ME 544
- **Additional Courses (2 courses)**
  - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **4 aerospace seminars**
- **Aerospace research presentation delivered to program faculty**

Concurrent Graduate Certificates

AI for Materials (aiM) Certificate

Program Code: E-AIM-C
Degree Designation: Certificate
Department: Computer Science
Website: aim-nrt.pratt.duke.edu

Program Summary

Program administrator: Shana McAlexander (shana.mcalexander@duke.edu)

Concepts of AI and data science are increasingly applied in the realm of materials research in order to discover, develop, and design new materials for critical applications with reduced time and cost. Computational methods that can rapidly predict targeted properties for different material classes, as well as the increasing emergence of materials data warehouses holding arrays of experimental data for applications ranging from aerospace components to biomedical implants to flexible electronics. Certificate holders will be trained in both materials fundamentals and data science principles and will be empowered to tackle critical problems in the semi-infinite design space for materials. This certificate is open to all MS, MEng, and PhD students at Duke University.

Admissions Policies and Practices

To apply for admissions, students submit a form to the certificate program administrator attesting to understanding the certificate requirements. Each semester, a list of participating students will be shared with Pratt administrators to be entered into DukeHub. Once the student has completed the certificate requirements, the administrator and faculty advisor will review the student's transcript and project/internship documentation (if applicable), sign off on completion, and report approval of the certificate to Pratt administrators.

Deadlines: Participating students may apply for the certificate anytime during their degree program as long as they meet the deadlines of July 1 for Fall graduation and November 1 for Spring graduation. Certificates are awarded upon completion of the student's degree program.

Students should have or develop proficiency in Python. The course instructors will set the prerequisites for enrollment in each course.

Academic Requirements

12 units, 4 classes

- **Required Courses (3 courses)**
  - 1 Materials Science Foundations course
  - 1 Machine Learning Foundations course
  - 1 Machine Learning and Materials Applications course
  - A comprehensive list of courses is available to students on the program webpage and the Stellic degree audit site.
- **Project or Internship**
  - ME 555 (DATA & MAT SCI PROJ CAPSTONE)
  - Other research project course, independent study, internship, or external research experience, with pre-approval

Concurrent Graduate Certificates

Biomedical Data Science Certificate

Program Code: E-DATSCI-C
Degree Designation: Certificate
Department: Biomedical Engineering
Website: bme.duke.edu/masters/certificates/biomedical-data-science

Program Summary

Professor Sina Farsiu, Director of Certificate Program, Anderson-Rupp Professor of Biomedical Engineering

Biomedical engineering has become a prime discipline for applying data science techniques—and the job market for biomedical engineers with data science skills is expanding rapidly. With its pioneering expertise and leadership in biomedical engineering, machine learning, signal and image processing, and biostatistics, Duke is the ideal place to learn how to translate biomedical data into actionable health insights. By collaborating with and learning from leading researchers, students who earn a Biomedical Data Science Certificate can increase their competitiveness for positions in industry and doctoral programs.

Enrollment in the four-course Master's Certificate in Biomedical Data Science is open to the BME Master of Engineering (MEng), BME Master of Science (MS), or Master of Engineering in Medical Technology Design (MedTech) students intending to pursue careers or enter doctoral programs relating to biomedical data science.

Academic Requirements

- **BME Courses (2 courses)**
  - A comprehensive list of courses is available to students on the program webpage and the Stellic degree audit site.
- **Optional Courses (2 courses)**
  - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **Complete a biomedical data science-relevant project** and submit a two-page abstract to the Biomedical Data Science Committee. The project could result from previous course projects, independent study, or a master's thesis. It must have a non-trivial technical novelty and demonstrate proficiency in developing novel methodologies or scientifically utilizing a broad range of advanced data science tools to solve impactful biomedical problems.

Concurrent Graduate Certificates

Biotechnology Certificate

Program Code: E-BIOTEK-C
Degree Designation: Certificate
Department: Biomedical Engineering
Website: bme.duke.edu/masters/certificates/biotech

Program Summary

The Department of Biomedical Engineering offers a certificate in biotechnology. This certificate provides BME master's students with in-depth knowledge of cutting-edge techniques for modeling, analyzing, and designing molecular and cellular systems. Working with faculty who are leaders in the field, students will gain hands-on experience in molecular biology, protein expression and purification, and gene editing. This certificate is ideal preparation for careers in the fast-growing biotech industry. This certificate is open to students in the BME Master of Engineering (MEng) or Master of Science (MS) programs.

Academic Requirements

Select four courses, including at least one that has a lab

- **Lab Requirement (1 course)**
  - BME 570L
  - BME 590L
- **Additional Courses (3 courses)**
  - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Concurrent Graduate Certificates

Computational and Digital Health Certificate

Program Code: E-COMPDH-C
Degree Designation: Certificate
Department: Biomedical Engineering
Website: comphealth.duke.edu

Program Summary

Advances in artificial intelligence, wearable sensors, digital twins, and extended reality are transforming how we diagnose, monitor, and treat disease. As these technologies reshape healthcare, there is a growing need for engineers who understand both the computational tools and the clinical contexts in which they operate. With Duke's leadership in high-performance computing, biomedical engineering, and clinical innovation, students in the Computational and Digital Health Certificate program will gain the skills needed to design, evaluate, and implement technologies that improve patient outcomes. Through interdisciplinary coursework and collaboration with faculty in engineering, medicine, and ethics, students will develop a strong foundation in both technical methods and healthcare-specific challenges—such as data privacy, algorithmic bias, and real-world deployment. Graduates of the program will be well positioned for careers in industry, research, or medical technology development, and equipped to lead the future of digital health innovation.

Enrollment in the five-course PhD Certificate in Computational and Digital Health is open to PhD students intending to pursue careers relating to computational and digital health.

Academic Requirements

- **Required Courses (5 courses)**
  - 2 CDH electives
  - 1 Non-engineering Biomedical course
  - 1 Biostatistics course
  - 1 Bioethics course
  - A comprehensive list of courses is available to students on the program webpage and the Stellic degree audit site.
- **5 Communities of Practice sessions**
  - Participate in at least five Communities of Practice (CoP) sessions during the program, engaging with a cross-disciplinary community through trainee-led discussions, research chalk talks, and ethical reflections on topics such as AI bias and wearable technology performance. CoP activities are designed to build technical fluency, professional networks, and leadership skills in digital health.

Concurrent Graduate Certificates

Medical Device Design Certificate

Program Code: E-MEDDEV-C
Degree Designation: Certificate
Department: Biomedical Engineering
Website: bme.duke.edu/masters/degrees/medtech-design

Program Summary

The Department of Biomedical Engineering offers a certificate in Medical Device Design. Through this certificate, BME master's students will gain engineering skills relevant to device design, including electrical, software, and mechanical aspects. This program will explore the device development process, including design ethnography, regulatory controls, manufacturing strategies, and verification and validation testing. Students in this program can expect to be well-prepared for a career in the medical equipment industry. This certificate program is available to students enrolled in Duke's MS and MEng programs in Biomedical Engineering.

Students typically apply for the MedTech graduate certificate during their first semester at Duke. The certificate is completed during the second and third semesters.

Academic Requirements

- **Required Courses (2 courses)**
  - BME 774L
  - BME 673L
- **Embedded Medical Devices or Quality Systems (1 course)**
  - BME 554L
  - BME 590 (QUALITY SYSTEMS FOR BME)
- **Design Health (1 course)**
  - BME 773L
  - BME 775L

Concurrent Graduate Certificates

Medical Robotics and Surgical Technologies Certificate

Program Code: E-MRST-C
Degree Designation: Certificate
Department: Biomedical Engineering
Website: mems.duke.edu/masters/certificates/medical-robotics

Program Summary

Skilled surgeons today leverage the capabilities of robotics to extend their already-amazing abilities beyond the limits of what the human hand and eye can do. Tomorrow, surgeons will rely even more on precision medical robots to provide even better surgical results with fewer complications and less pain—all leading to greater well-being for patients. You can shape this future by enhancing your Duke master's or PhD with the Graduate Certificate in Medical Robotics. In addition to completing four high-impact courses, you'll join a special community—the uncommonly collaborative engineering and medical research neighborhood clustered just meters apart along Duke's Research Drive.

This certificate is available to ECE, CEE, MEMS, CS, Data Science, Math, Statistics, Medical Physics and, Science & Society. To apply, contact the Program Coordinator for Duke's NSF Traineeship in the Advancement of Surgical Technologies (TAST) program.

Academic Requirements

4 courses (3 credits each) = 12 credits required for certificate completion

- **Required Courses (2 courses)**
  - ME 555 (INTRO MED ROBOTICS SURG TECH)
  - ME 555 (PROJECTS MED ROBOT & SURG TECH)
- **Additional Courses (2 courses)**
  - 1 Machine Learning course
  - 1 elective
  - A comprehensive list of courses is available to students on the program webpage and the Stellic degree audit site.
- **Internship or Research Project**

Concurrent Graduate Certificates

Neural Engineering Certificate

Program Code: E-NEURAL-C
Degree Designation: Certificate
Department: Biomedical Engineering
Website: bme.duke.edu/masters/certificates/neural-engineering

Program Summary

The Department of Biomedical Engineering offers a certificate in Neural Engineering. Focusing on the importance of identifying and treating nervous system disorders and diseases, this certificate introduces students to the analytical and practical skills necessary in the field of neural engineering. Students who complete the Neural Engineering certificate are well-positioned to become research engineers, development engineers in the medical device industry, or successful candidates in doctoral programs. This certificate is open to students in the BME Master of Engineering (MEng), Master of Science (MS), and PhD programs, and the Medical Technology Design Master of Engineering program.

Academic Requirements

- **Neural Engineering Course (1 course)**
  - BME 601L

- **Additional Courses (4 courses)**
    - 1 Physiology course
    - 3 Neural electives
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.

Concurrent Graduate Certificates

Robotics and Automation Certificate

Program Code: E-ROBOT-C
Degree Designation: Certificate
Department: Mechanical Engineering
Website: mems.duke.edu/masters/certificates

Program Summary

The Department of Mechanical Engineering and Materials Science offers a certificate in Robotics and Automation. This certificate provides master's and PhD students with in-depth knowledge of cutting-edge techniques for modeling, analyzing, and designing robotic systems. Working with faculty who are leaders in the field, students will gain experience in robot learning, kinematics, dynamics, and control. This certificate is ideal preparation for careers in the fast-growing robotics industry. This certificate is open to all MS, MEng, and PhD students in Pratt and Computer Science.

Academic Requirements

4 courses (3 credits each) = 12 credits required for certificate completion

- **Required Courses (2 courses)**
    - ME 555 (ADVANCED ROBOT SYSTEM DESIG)
    - ME 555 (ROBOT LEARNING)
- **Additional Courses (2 courses)**
    - 1 Controls & Dynamics course
    - 1 elective
    - A comprehensive list of elective courses is available to students on the program webpage and the Stellic degree audit site.
- **E-portfolio**
    - Students will document their work on internships, course projects, and research in an e-portfolio

Standalone Graduate Certificates

The Pratt School of Engineering offers rigorous standalone and concurrent graduate certificate programs that recognize students for work in leading-edge areas of multidisciplinary research. These certificate programs provide graduate students with advanced training in interdisciplinary or emerging fields of knowledge.

- AI Foundations for Product Innovation
- Business Foundations for Engineers
- Innovation for Defense

Standalone certificates are designed for individuals who are not currently or have not previously been enrolled in a Pratt master's program but are seeking to strengthen their professional skills. Pratt's standalone certificates also serve as a strong foundation for individuals who may consider pursuing an advanced degree in an engineering field, and the credits earned from this credential may be applied to appropriate Pratt master's programs. Students enrolled in standalone certificate programs are subject to the Duke Community Standard and Pratt School of Engineering academic standards.

Additional information regarding application processes, deadlines, and curriculum requirements for each certificate program is available on the certificate's website.

Standalone Graduate Certificates

AI Foundations for Product Innovation Certificate

Program Code: E-AIPI-C
Degree Designation: Certificate
Department: Master of Engineering Program
Website: masters.pratt.duke.edu/ai/certificate

Program Summary

This standalone, credit-bearing program is designed for working professionals in STEM fields who seek to gain AI skills that may be applied to their organization or industry. The Artificial Intelligence Foundations for Product Innovation graduate certificate requires the completion of four Master of Engineering in Artificial Intelligence for Product Innovation program online courses (12 units). In addition to the four courses, certificate students are required to participate in a Python programming bootcamp.

Admissions Policies & Practices

The Duke AI Foundations for Product Innovation Graduate Certificate is designed for working professionals with a technical or scientific background. Participants are expected to be working full-time while completing the Certificate program.

Applicants should have:

- An undergraduate degree in science or engineering (or equivalent technical work experience), *and*
- Proficiency in one or more programming languages (Python preferred), *and*
- Sufficient DUOLINGO, IELTS, or TOEFL English Language Testing scores (official results required; international students only), *and*
- Two (2) semesters of calculus

International applicants please note that this standalone certificate program does not qualify students for US visa sponsorship.

Applying for the MEng in Artificial Intelligence for Product Innovation Online Program as a Certificate Holder

Students who enroll and successfully complete the certificate requirements will have the option to subsequently apply for the Master of Engineering in Artificial Intelligence for Product Innovation Online Program within four years and use their certificate courses (12 units) toward the degree (30 units) as long as they earn a grade of B or better in each class. Certificate holders who apply to the MEng in Artificial Intelligence for Product Innovation Online Program will additionally be required to provide GRE scores (if required at time of application) and complete all course requirements for the degree (e.g., three electives, two Pratt MEng management core courses, an industry project and the required on-campus residencies in Durham, NC).

Academic Requirements

- **Required Courses (4 courses)**
  - AIPI 503
  - AIPI 510
  - AIPI 520
  - AIPI 540
- **Elective (1 course)**
  - Any 3-credit AIPI course 511-590, excluding the required courses

Standalone Graduate Certificates

Business Foundations for Engineers Certificate

Program Code: E-BUSFDN-C
Degree Designation: Certificate
Department: Engineering Management Program
Website: memp.pratt.duke.edu/certificate

Program Summary

The Master of Engineering Management Program sponsors a Business Foundations for Engineers graduate certificate. This standalone, credit-bearing program provides experienced STEM professionals with a foundational business education in a technical context. The certificate program enables working technical professionals to cultivate a competitive advantage by building skills in the domains of marketing, finance, management, and law. The Business Foundations for Engineers graduate certificate is designed for working professionals and requires completion of the four core EGRMGMT online courses (12.0 course credits).

Admissions Policies and Practices

The certificate program is open to all qualified applicants worldwide. Students who have passed Calculus I, Calculus II, Calculus III, Statistics, or another math course beyond Calculus II among other technical electives during their undergraduate coursework will be best prepared for the academic rigor of the certificate program.

Applications are accepted for the certificate program for both the fall and spring semesters. Admission to the Business Foundations for Engineers Graduate Certificate Program requires the following:

- a bachelor's degree in engineering or science from an accredited institution (transcripts required, including an estimated GPA and a grade scale);
- statement of purpose;

- résumé;
- two recommendations;
- English Language Testing (TOEFL or IELTS): official results required (international applicants only);
- a nonrefundable application fee of $75 USD to be paid via credit card; and
- an interview.

This is a standalone certificate and does not qualify international students for US visa sponsorship.

Students apply in accordance with existing application deadlines for the campus and online MEM programs.

Students who enroll and successfully complete the certificate requirements will have the option to subsequently apply for the Master of Engineering Management Online Program (MEM Online) within four years and use their certificate courses (12 course credits) toward the degree (30 course credits) as long as they earn a grade of B or better in each class. Certificate holders who apply to MEM Online will additionally be required to provide GRE scores and complete all course requirements for the degree.

Academic Requirements

- **Required Courses (4 courses)**
  - EGRMGMT 510
  - EGRMGMT 520
  - EGRMGMT 530
  - EGRMGMT 540

Standalone Graduate Certificates

Innovation for Defense Certificate

Program Code: E-INNDEF-C
Degree Designation: Certificate
Department: Engineering Management Program

Program Summary

The Innovation for Defense Certificate is a standalone, credit-based offering requiring completion of the following three EGRMGMT courses plus one elective (12 credits total) that is aimed at STEM professionals in the U.S. military and related fields enabling them to define innovation challenges in technology within the defense or government sectors and their impact on value creation for all stakeholders and apply a broad range of innovation frameworks to drive their innovation initiative towards success. Students will discover ways to engage with DoD in ways that move an innovation towards funding, mission alignment and adoption. All courses would be online only, with the exception of Design Defense Studio, which has both online and on-campus components.

Admissions Policies & Practices

The Design Defense Studio course is open to all and targeted at students in the military or related sectors and students applying for the certificate program should meet the same minimum and preferred application requirements as those applying for the MEM program: masters.pratt.duke.edu/apply/instructions/#h-graduate-certificates.

Applicants will apply as non-degree candidates for the certificate program. The application process requires submission of the following:

- Transcript of bachelor's degree in engineering or science earned from an accredited institution, which may also include an estimated GPA and a grade scale
- Resume
- Responses to short essay questions
- 2 letters of recommendation
- Application fee – Non-refundable, paid by credit card (note that fee is waived for active members, reservists, or veterans of the U.S. Armed Forces)
- Video introduction

This is a standalone certificate and does not qualify international students for US visa sponsorship.

Students apply in accordance with existing application deadlines for the campus and online MEM programs.

Applying for the Master of Engineering Management degree as a Certificate Holder

Students who enroll and successfully complete the certificate requirements will have the option to subsequently apply for the Master of Engineering Management Online Program (MEM Online) within four years and use their certificate courses (12 course credits) toward the degree (30 course credits) as long as they earn a grade of B or better in each class. Certificate holders who apply to MEM Online will additionally be required to provide GRE scores and complete all course requirements for the degree.

Academic Requirements

- **Required Courses (3 courses)**
  - EGRMGMT 590 (Design Defense Studio)
  - EGRMGMT 512
  - EGRMGMT 560
- **Technical Elective (1 course)**
  - EGRMGMT 572, 574, or 576, or other options as approved by MEM leadership & course instructor

Early Career Program and 4+1 Program for Duke Students

Early Career Program

Recent graduates of a Duke University bachelor's degree program can apply for the Early Career Program up to five years after graduation.

Students enrolled in the Early Career Program will follow the standard application deadlines. Admission must be approved by the department/program in which the master's degree is sought and by the Pratt School of Engineering. Applicants are not required to take the GRE and are not charged an application fee.

Recent graduates who have unused graduate-level (at the 500 level or above) elective credits as part of their undergraduate degree can transfer up to 4 courses.

4+1 Program for Duke Students

Advanced Duke undergraduates may participate in a 4+1 Program where both a bachelor's degree and a MEM/MEng degree may be completed in about five years. In the 4+1 Program, students may typically apply up to four graduate courses (at the 500 level or above) that were taken during their undergraduate career but not used to fulfill undergraduate degree requirements toward master's degree requirements.

Additional academic policies for Duke undergraduates in the 4+1 Program can be found at prattprofessional.bulletins.duke.edu/policies/academic/early-programs.

To be considered for the 4+1 program, undergraduates may apply for a MEM/MEng admission decision during the standard admission cycle for entrance. Applicants are not required to take the GRE and are not charged an application fee. Students should plan to apply in the semester before admission:

- apply in the spring of junior year for admission in the fall semester of senior year; or
- apply in the fall of senior year for admission in the spring semester senior year.

Admission decisions will be made and communicated to the student following the published admissions decision calendar. Although an admission decision may be made before or during the student's senior year, matriculation into the MEM/MEng Program will generally not occur until the undergraduate degree has been earned. Matriculation will occur in Summer Session 1 after the spring semester of the senior year unless a student opts for the 4+1 deferred enrollment option. Therefore, students will pay undergraduate tuition for the first four years of study and will pay Pratt tuition for the fifth year of study. The 4+1 deferred enrollment option allows a student to defer enrollment for up to 3 years.

MEM and MEng courses are not typically available to undergraduates. Undergraduate 4+1 students work with the student records coordinator to register for courses. Not all graduate-level courses are available to undergraduates, and registration will only be provided for approved courses. If a 4+1 student desires to take graduate-level elective classes that are not available to undergraduates, they should plan to take these courses in the fifth year of study.

The following rules apply when transferring graduate courses taken as an undergraduate:

- in general, a maximum of four graduate-level courses may be transferred to the MEM/MEng degree
- transferred courses may not have been used to fulfill any undergraduate degree requirements
- transferred courses must fulfill MEM/MEng degree requirements in the major of interest
- a grade of B or better must have been earned in the course
- grades earned are not used to calculate the MEM/MEng GPA

To transfer course credit, students must complete the Pratt Credit Transfer Form and obtain approval from their undergraduate dean and the program director of the master's program.

For 4+1 students in the Trinity College of Arts & Sciences, additional undergraduate courses may be required as prerequisites in addition to master's program requirements. It is suggested that 4+1 students discuss their program of study with the program director to understand the expectations in earning the degree. Depending on the extent of the prerequisite courses required, it may not be possible to complete the master's degree in only one additional year.

All Courses

AIPI501 - AIPI Seminar

Course Description
Current topics in AI for Product Innovation. Seminars provide students opportunities to learn from industry leaders. Weekly sessions foster community and the development of a peer network within the cohort.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
0

Max Units:
0

AIPI503 - Python Bootcamp

Course Description
Introductory Python programming and probability and statistics bootcamp to prepare students for Fall programming courses. Students who already have proficiency in Python will have opportunities to test out of portions of the boot camp.

Grading Basis
Credit / No Credit

Course Typically Offered
Occasionally

Units

Min Units:
0

Max Units:
0

AIPI504 - Introductory Residency

Course Description
One week course to introduce the Master of Engineering in AI for Product Innovation Online Program. Residency 1 includes an orientation to Duke and the program, case studies, professional development workshops and alumni engagement opportunities. Prerequisite: Enrollment in the Master of Engineering in AI for Product Innovation Online Program.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall Only

Units

Min Units:
0

Max Units:
0

AIPI505 - Mid-Program Residency

Course Description
One week course to assess interim progress for the Master of Engineering in AI for Product Innovation Online Program. Residency 2 includes team-building exercises, case studies, workshops, seminars and engagement opportunities. Prerequisite: Enrollment in the Master of Engineering in AI for Product Innovation Online Program, AIPI 504.

Grading Basis
Credit / No Credit

Units

Min Units:
0

Max Units:
0

AIPI510 - Sourcing Data for Analytics

Course Description
Course introduces students to the technical and non-technical aspects of collecting, cleaning and preparing data for use in machine learning applications. Technical aspects covered will include the types of data, methods of sourcing data via the web, APIs and from domain-specific sensors and hardware, an increasingly common source of analytics data in technical industries. The course also introduces methods and tools for evaluating the quality of data, performing basic exploratory data analysis, and pre-processing data for use in analytics. Non-technical aspects covered include an introduction to data privacy, GDPR, regulatory issues, bias and industry-specific concerns regarding data usage.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

AIPI520 - Modeling Process and Algorithms

Course Description
This course is an introduction to the modeling process and best practices in model creation, interpretation, validation, and selection of models for different uses. The primary machine learning algorithms, both supervised and unsupervised, are introduced and explained with the necessary level of mathematical theory to establish students' intuition for how each algorithm works. At the end of this course, students should have a solid understanding of the end-to-end modeling process and the different types of model algorithms along with the strengths, weaknesses, assumptions, and use cases for each type.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

AIPI530 - Optimization in Practice

Course Description
Optimization is the ultimate skill in artificial intelligence and prescriptive analytics allowing practitioners to generate the best actionable solutions for business needs. This class will give students required skills to mathematically formulate relevant business problems as optimization models, use leading software modeling syntax and solvers to generate optimum solutions and meaningfully interpret these solutions. We will use both SAS/Optmodel and Python/Pyomo to give student experience with proprietary and open-source optimization software. Focus will be on problem formulation and results interpretation.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

AIPI531 - Deep Reinforcement Learning Applications

Course Description
Deep Reinforce. Learning Appl. will cover advanced sequential decision-making topics in AI and will consist of two parts 1) deep reinforce. learning theory and 2) deep reinforce. learning applications. Deep reinforce. learning combines reinforce. learning and deep learning. The theory module will introduce students to major deep reinforce. learning algorithms, modeling process, and programming. The applications module will include case studies on the practical applications of deep reinforce. learning in industry. This is a project-based course with extensive Pytorch/Tensorflow hands-on exercises. Students will also have an opportunity to improve their GitHub profile by working on projects.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

AIPI540 - Deep Learning Applications

Course Description
This course focuses on the primary use cases of deep learning to solve challenging problems particularly in the areas of computer vision, natural language processing, and recommendation systems. Students will develop an understanding of both the mathematical theory and programmatic implementation of neural networks using Python. The course includes significant hands-on team-based project work and an emphasis on self-discovery. The semester will be split into three core modules: computer vision, NLP, and recommendation systems. Each module will include lectures, assignments, a team project, and review of recent research in the field.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

AIPI549 - Capstone Practicum 1

Course Description
First of two courses comprising the AIPI capstone practicum project experience. Students will work in teams on a real-world AI-related project for an industry sponsor. Students will conduct the end-to-end research, definition, design, prototyping and evaluation of an AI model integrated into a new or existing product or system. Prerequisite: AIPI 510 and 520, and enrollment in the Master of Engineering in Artificial Intelligence for Product Innovation.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

AIPI560 - Legal, Societal, and Ethical Implications of AI

Course Description
Deploying AI within products and services has implications well beyond the technical considerations, which often include change management of operational workflows or staffing levels, data privacy considerations, bias risks and other ethical implications, and industry-specific regulations on the use of data and models operationally. This course will introduce students to the key areas of consideration when deploying products which contain AI: 1) legal implications and industry regulation, 2) ethical considerations, and 3) change management and organizational/societal implications. Case studies will be used extensively to provide real-world examples.

Grading Basis
Graded

Course Typically Offered
Summer Only

Units

Min Units:
1.5

Max Units:
1.5

AIPI561 - Operationalizing AI

Course Description
Deploying AI in production requires consideration of factors such as online model training, scaling, integration with software/hardware products, monitoring/support, security and failure resiliency. This course introduces students via readings and real-world case studies to methods and best practices in deploying AI operationally within products and services, including both technology and support infrastructure considerations. The course will also introduce, although not go into deep technical detail on, the available technologies for working with Big Data in certain industries which require specialized infrastructure and tools due to the volume of data.

Grading Basis
Graded

Course Typically Offered
Summer Only

Units

Min Units:
1.5

Max Units:
1.5

AIPI590 - Advanced Topics in AI for Product Innovation

Course Description
Opportunity for study of advanced subjects related to programs within AI for Product Innovation tailored to fit the requirements of a small group.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

AIPI591 - Special Readings in AI for Product Innovation

Course Description
Individual readings in advanced study and research areas of AI for Product Innovation. Prerequisite: Enrollment in the Master of Engineering in AI for Product Innovation Program. Consent of instructor required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
3

BME503 - Computational Neuroengineering (GE, EL)

Course Description
This course introduces students to the fundamentals of computational modeling of neurons and neuronal circuits and the decoding of information from populations of spike trains. Topics include: integrate and fire neurons, spike response models, homogeneous and inhomogeneous Poisson processes, neural circuits, Weiner (optimal) adaptive filters, neural networks for classification, population vector coding and decoding. Programming assignments and projects will be carried out using MATLAB. Prerequisites: Biomedical Engineering 301L or equivalent.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
NEUROSCI503 COMPUTATIONAL NEUROENGINEERING

BME504 - Fundamentals of Electrical Stimulation of the Nervous System (EL, GE)

Course Description

This course presents a quantitative approach to the fundamental principles, mechanisms, and techniques of electrical stimulation required for non-damaging and effective application of electrical stimulation. Consent of instructor required. Prerequisite: BME 301L or graduate standing. (EL, GE)

Grading Basis

Graded

Course Typically Offered

Occasionally

Units

Min Units:

3

Max Units:

3

Crosslisted Courses

NEUROSCI504 FUND ELEC STIM NERV SYS

BME505L - Biopotential Amplifiers and Implant Devices (GE, EL, IM)

Course Description

This course will cover fundamental principles and circuits for implantable medical devices, geared to advanced undergraduates and graduate students interested in understanding the basics of hardware design for implantable neurological devices. Specific circuit examples of low-power amplifiers and implantable devices will be discussed. A system level approach that optimizes performance, reliability and power consumption will be emphasized. In parallel, printed circuit board design and fabrication will be presented. Principles of bioinstrumentation will be reinforced through practical design exercises. Prerequisite: BME 301L or graduate standing. (EL, IM, GE).

Grading Basis

Graded

Course Typically Offered

Occasionally

Units

Min Units:

3

Max Units:

3

BME506 - Measurement and Control of Cardiac Electrical Events (GE, EL, IM)

Course Description

Design of biomedical devices for cardiac application based on a review of theoretical and experimental results from cardiac electrophysiology. Evaluation of the underlying cardiac events using computer simulations. Examination of electrodes, amplifiers, pacemakers, and related computer apparatus. Construction of selected examples. Prerequisites: Biomedical Engineering 301L; 354L or instructor consent.

Grading Basis

Graded

Course Typically Offered

Occasionally

Units

Min Units:

3

Max Units:

3

BME507 - Cardiovascular System Engineering, Disease and Therapy (GE, BB, EL)

Course Description

Introductory and advanced topics in anatomy, physiology, pathophysiology, and modeling of the cardiovascular system. Theoretical and bioengineering concepts of heart electrical and mechanical function and circulatory system at cellular, tissue, and organ level. Computational models of cardiac electrical and mechanical activity and pressures and volumes within circulatory system. Contemporary cell, gene, and device-based therapies for treatment of cardiac and cardiovascular disease. The course enhances students' knowledge of cardiovascular system function with the emphasis of underlying engineering principles. Prerequisites: two of Biomedical Engineering 301L, 302L, 307 or graduate standing in BME.

Grading Basis

Graded

Course Typically Offered

Occasionally

Units

Min Units:
3

Max Units:
3

BME510 - Bayesian Analysis in Biomedical Engineering (GE, EL)

Course Description
The application of Bayesian statistics to questions in BME broadly with a focus on electrotrocardiography. Topics include a brief history of Bayesian math in biology and medicine, use of likelihood functions and prior distributions, the Bayesian outlook toward medical diagnosis, the work of Cornfield, Pipberger, and Dunn on the classification of electrocardiograms, and a Bayesian framework for the cardiac inverse problem. The approaches used for these topics can be adapted to many other BME situations. Prerequisite: Senior or graduate standing.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

BME512L - Cardiac Bioelectricity (GE, EL)

Course Description
Electrophysiological behavior of cardiac muscle. Emphasis on quantitative study of cardiac tissue with respect to propagation and the evaluation of sources. Effect of junctions, inhomogeneities, anisotropy, and presence of unbounded extracellular space. Bidomain models. Study of models of arrhythmia, fibrillation, and defibrillation. Electrocardiographic models and forward simulations. Laboratory exercises based on computer simulation, with emphasis on quantitative behavior and design. Readings from original literature. Prerequisite: Biomedical Engineering 301L or equivalent.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
4

Max Units:
4

BME513 - Introduction to Neurodynamics (EL, GE)

Course Description
Behavior of neurons and neuronal networks examined with methods of nonlinear dynamics. Interpretation in phase space of excitability, spiking, bursting, phase locking, synchronization, competition, and chaos. Applications to the development of novel neurostimulation methods and to understanding dynamic mechanisms behind sensing, learning, memory, and cognition. Readings from the original literature. Prerequisites BME 301L, graduate standing or consent of instructor. (EL, GE)

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
NEUROSCI513 INTRO NEURODYNAMICS

BME515 - Neural Prosthetic Systems (GE, EL, IM)

Course Description
Covers several systems that use electrical stimulation or recording of the nervous system to restore function following disease or injury. For each system, the underlying biophysical basis for the treatment, the technology underlying the treatment, and the associated clinical applications and challenges are examined. Systems to be covered include cochlear implants, spinal cord stimulation of pain, vagus nerve stimulation for epilepsy, deep brain stimulation for movement disorders, sacral root stimulation for bladder dysfunction, and neuromuscular electrical stimulation for restoration of movement. Prerequisite: BME 301L or ECE 110L.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
NEUROSCI515 NEURAL PROSTHETIC SYSTEMS

BME517 - Neuronal Control of Movement (GE, EL)

Course Description
Course for graduate and upper-level undergraduate students to provide them with an understanding of the neuronal circuits that move our bodies and with techniques for analysis, simulation, and modification of these circuits by neural engineers. Topics start in the periphery with muscles, the spine, and functional electrical stimulation; then proceed centrally to subcortical circuits, deep brain stimulation, and forward models; and conclude with cerebral cortical networks and population decoding. Students are expected to have background in bioelectricity and Matlab programming. Prerequisite: BME 301L or consent of the instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
NEUROSCI517 NEURONAL CONTROL OF MOVEMENT

BME518L - Modern Neuroscience Tools (GE, IM, EL)

Course Description
This course introduces students to the various modern tools used to study the function of the brain, and the underlying biophysics of these tools. Content will focus on novel technologies and techniques that employ electrophysiology and optogenetics. Prerequisite: BME 301L.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

General Education Curriculum Codes
(QS) Quantitative Studies

BME520L - Computational Foundations of Biomedical Simulation (GE, BB, MC)

Course Description
This is an applications course highlighting the use of parallel simulation in solving biomedical problems. The goal is to provide a foundation in the tools and methods for building and implementing applications for parallel architectures including source-code control and testing frameworks. Topics will include computational abstraction, performance profiling and analysis, scalability, thread- and core-level parallelism, I/O, and visualization. Prerequisites: BME 302L or BME 307 or graduate standing.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
4

Max Units:
4

General Education Curriculum Codes
(QS) Quantitative Studies

BME524 - Nanotechnology in Medicine (GE, BB, MC)

Course Description
Nanomedicine impacts biomedical sciences by applying nanotechnology to develop devices with nanoscale features for applications in therapeutics, diagnostics, and molecular tools. The course covers the application of nanotechnology to advance drug therapy, gene therapy, immunotherapy, and cell therapy and discusses engineering design and fabrication strategies for practical implementation. Most recent advances in the field will be discussed. Student's critical understanding will be evaluated through written or oral presentations. Prerequisite: BME 302L or BME 307 or permission of the instructor.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

BME526 - Elasticity (GE, BB)

Course Description
Linear elasticity will be emphasized including concepts of stress and strain as second order tensors, equilibrium at the boundary and within the body, and compatibility of strains. Generalized solutions to two and three dimensional problems will be derived and applied to classical problems including torsion of noncircular sections, bending of curved beams, stress concentrations and contact problems. Applications of elasticity solutions to contemporary problem in civil and biomedical engineering will be discussed. Prerequisites: Engineering 201L; Mathematics 353.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
CEE521 ELASTICITY

BME527 - Cell Mechanics and Mechanotransduction (GE, BB, MC)

Course Description
An examination of the mechanical properties of cells and forces exerted by cells in biological processes of clinical and technological importance, and the processes by which mechanical forces are converted into biochemical signals and activate gene expression. Topics include measurement of mechanical properties of cells, cytoskeleton mechanics, models of cell mechanical properties, cell adhesion, effects of physical forces on cell function, and mechanotransduction. Students critically evaluate current literature and analyze models of cell mechanics and mechanotransduction. Prerequisite: BME 302L or BME 307; knowledge of cell biology.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

BME528 - Biofluid Mechanics (GE, BB, MC)

Course Description
Methods and applications of fluid mechanics in biological and biomedical systems including: Governing equations and methods of solutions, (e.g. conservation of mass flow and momentum), the nature of biological fluids, (e.g. non Newtonian rheological behavior), basic problems with broad relevance, (e.g. flow in pipes, lubrication theory), applications to cells and organs in different physiological systems, (e.g. cardiovascular, gastrointestinal, respiratory, reproductive and musculoskeletal systems), applications to diagnosis and therapy, (e.g. drug delivery and devices). Prerequisite: Biomedical Engineering 307 or graduate student standing.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME529 - Properties and Characterization of Polymeric Materials

Course Description
An introductory graduate-level course in soft condensed matter physics dealing with the synthesis, structure, and properties of polymers, biopolymers and polymeric materials. The course provides a brief introduction to polymer syntheses based on chemical reaction kinetics, it covers polymer characterization and a broad range of properties of polymers and polymeric materials, including solution properties, thermal properties, rheological and mechanical properties, and surface properties. Some topics will be explored in more detail through semester projects, presented at a Polymer Symposium at the end of the semester. Open only to graduate students.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ME514 PROPER & CHARACT POLYMERIC MAT

BME530 - Introduction to Tissue Biomechanics (GE, BB)

Course Description
Introduction to the mechanical behaviors of biological tissues, cells and molecules of the musculoskeletal and cardiovascular systems. Topics to be covered include static force analysis and nonlinear optimization theory; linearly elastic models for stress-strain analysis and solutions to relevant problems in bioelasticity; models of active structures (e.g., muscles); and introductory theory for finite element analysis. Emphasis will be placed on modeling stress-strain relations with relevance to biological tissues, including experimental means to measure stress and strain in these structures. Prerequisites: Engineering 201 or equivalent; Biomedical Engineering 302 or equivalent; Mathematics 353.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

BME531 - Intermediate Biomechanics (GE, BB)

Course Description

Introduction to solid and orthopaedic biomechanical analyses of complex tissues and structures. Topics to be covered include: spine biomechanics, elastic modeling of bone, linear and quasi-linear viscoelastic properties of soft tissue (for example, tendon and ligament), and active tissue responses (for example, muscle). Emphasis will be placed on experimental techniques used to evaluate these tissues. Student seminars on topics in applied biomechanics will be included. Prerequisite: Engineering 201L; Mathematics 353.

Grading Basis

Graded

Units

Min Units:

3

Max Units:

3

BME532 - Viscoelastic Biomechanics (GE, BB)

Course Description

This is a fundamental course on the behavior of biological systems from the engineering point of view. The course covers state-of-the-art mechanical models to describe the constitutive behavior of hard and soft, and will include the dependence of macroscopic behavior and properties on material microstructure Emphasis is placed on linear viscoelastic models but quasi-linear and nonlinear forms are introduced to advanced topics will also be provided based on current research and student interest. Prerequisites BME 302L, Math 353 or graduate standing (GE, BB).

Grading Basis

Graded

Course Typically Offered

Fall Only

Units

Min Units:

3

Max Units:

3

BME535 - Biomedical Aspects of Blast and Ballistics (GE, BB)

Course Description

Introduction to the biomechanical basis and medical consequences of human injury from blast and ballistics. Exploration of blast and ballistics injuries in both biomechanics and medicine covering the etiology and state-of-the-art analytic and biomechanical models of human injury. Evolution of medical opinion compared to contemporary knowledge of ballistics and blast. Focus on injuries to the head, neck, thorax, abdomen and extremities, and associated medical consequences, including shock, immune system response, traumatic brain injury (TBI) and posttraumatic stress disorder (PTSD). Prerequisite: Biomedical Engineering 302L, graduate standing, or consent of instructor.

Grading Basis

Graded

Course Typically Offered

Spring Only

Units

Min Units:

3

Max Units:

3

BME540 - Mobile Devices for Biomedicine(GE, IM)

Course Description

This course will develop hardware and software interfaces for recording and analyzing biomedical data using a mobile device, including tablets and handheld smartphones. Coursework includes homework assignments that focus on development of programming skills with an emphasis on delivery of a functioning platform as a final group project. Prerequisite: BME 303L (GE, IM)

Grading Basis

Graded

Course Typically Offered

Occasionally

Units

Min Units:
3

Max Units:
3

BME542 - Principles of Ultrasound Imaging (GE, IM)

Course Description
Propagation, reflection, refraction, and diffraction of acoustic waves in biologic media. Topics include geometric optics, physical optics, attenuation, and image quality parameters such as signal-to-noise ratio, dynamic range, and resolution. Emphasis is placed on the design and analysis of medical ultrasound imaging systems. Prerequisites: Biomedical Engineering 303; Engineering 103L; or instructor consent.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

BME543L - Cardiac Ultrasound Imaging and Function (GE, IM)

Course Description
Course combines medical instrumentation with a contrasting engineering and clinical perspective, with a focus on ultrasound cardiac imaging and measurement. The classroom aspect covers the physical basis of ultrasound cardiac imaging and measurements. The clinical component consists of cardiac anatomy and physiology, case studies, and clinical observations. The course includes two cardiac dissections and a hands-on experience in the Human Anatomy Lab. Students are required to develop image analysis software from supplied clinical 3D images to automatically determine quantitative physical descriptors of cardiac function. Prerequisite: Biomedical Engineering 354L or instructor consent. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME544 - Digital Image Processing (GE, IM)

Course Description
Introduction to the theory and methods for digital image sampling, enhancement, visualization, reconstruction, and analysis with emphasis on medical applications. Course Outline: #1: Introduction, history, and applications of image processing. #2: Spatial domain image enhancement. #3: Fourier domain image enhancement. #4: Image registration. #5: Inverse problems (denoising, deblurring, interpolation, and super-resolution). #6: Wavelets and compressive sensing. #7: Biological image processing. Undergraduate courses on signals and systems, probability and statistics recommended; knowledge of Matlab required. Prerequisites: Biomedical Engineering 271 or Electrical and Computer Engineering 280L or consent of the instructor. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

BME546 - Magnetic Resonance Imaging: Physical Principles and Sequence Design (GE, IM)

Course Description
An in-depth exploration of the physics and engineering in developing Magnetic Resonance Imaging (MRI). Topics covered include Gradient Recalled Echo, Spin Echo, Inversion Recovery, field of view and resolution constraints/requirements, signal processing, image artifacts, the Bloch Equation, fat suppression techniques, and the derivation of MR signal equation. Prerequisite: Biomedical Engineering 303 or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

BME547 - Medical Software Design (GE, IM)

Course Description
Software is critical in many medical devices, including device control, feedback and signal processing. This course focuses on software development skills that are ubiquitous in the medical device industry, including software version control, unit testing, fault tolerance, continuous integration testing and documentation. Experience will be gained in Python and JavaScript. The course will be structured around a project, done in small student groups, to build an Internet-connected medical device that measures and processes a biosignal, sends it to a web server, and makes those data accessible to a web client/ mobile application. Prerequisite: Biomedical Engineering 271, Biomedical Engineering 271A, or graduate student standing.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

General Education Curriculum Codes
QS - (QS) Quantitative Studies

BME548L - Machine Learning and Imaging (GE, IM)

Course Description
Deep learning is rapidly changing how we interpret image data. A large amount of research is now examining how we can use new machine learning tools to automatically interpret microscope, ultrasound and x-ray images, and MRI and CT scans, for example, to aid with diagnostic tasks. In this class, we will review how these machine learning tools work, with a particular focus on how they might be used in a diagnostic setting. This class will also investigate the specific question of how deep learning algorithms can be used to design imaging system hardware to improve performance, which will be the primary focus of the course final project. Prerequisite: BME 303L or graduate standing.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

BME550 - Modern Microscopy (GE, IM)

Course Description
Overview of novel microscopy techniques that are under development in research laboratories. New techniques are placed in context with basic understanding of image formation in conventional microscopy and laboratory work which applies this knowledge. A group project offers opportunity to examine special topics of interest. Prerequisite: Biomedical Engineering 354 and 303; consent of the instructor.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

BME551L - Biomedical Optical Spectroscopy and Tissue Optics (GE, IM)

Course Description
This course is designed to provide students with a working knowledge of the theoretical and experimental principles underlying the application of optical spectroscopy and tissue optics in biological and biomedical engineering. Topics covered in this course include: Absorption Spectroscopy; Scattering Spectroscopy; Fluorescence Spectroscopy; Tissue Optics; Monte Carlo Modeling; Diffusion Modeling; Spectroscopic System Design and Signal to Noise Analysis; and Molecular Imaging. This course also includes labs for each topic that is covered, journal article review on emerging technologies and a term project. Prerequisite: Physics 152L.

Grading Basis
Graded

Units

Min Units:
4

Max Units:
4

Crosslisted Courses
MOLCAN551L BME OPT SPECT TISSUE OPTICS

BME552 - Advanced Optics

Course Description
This course presents a rigorous treatment of topics in Photonics and Optics targeted at students with an existing photonics or optics background. Topics will include, Optical Sources, Statistical Optics and Coherence Theory, Detection of Radiation; Nonlinear Optics; Waveguides and Optical Fibers; Modern Optical Modulators; Ultrafast lasers and Applications. These topics will be considered individually and then from a system level perspective. Prerequisite: Electrical and Computer Engineering 340L or equivalent.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
PHYSICS621 ADVANCED OPTICS, ECE541 ADVANCED OPTICS

BME553 - Deep Tissue Optics (GE, IM)

Course Description
This course covers the fundamentals of biomedical optics and their applications to medical imaging and therapy. The course is divided into two parts: (1) fundamentals of photon transport in biological tissue and (2) optical imaging. Part 1 covers biomedical optics, single-scatterer theories, Monte Carlo modeling of photon transport, convolution for broadbeam responses, radiative transfer equation and diffusion theory, hybrid Monte Carlo method, and sensing of optical properties. Part 2 covers ballistic imaging, optical coherence tomography, diffuse optical tomography, photoacoustic tomography, and wavefront-engineering/adaptive optics. Prerequisites: BME 303L or graduate standing (GE, IM)

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

BME554L - Embedded Medical Devices (GE, IM, EL)

Course Description

This course will give students experience with the design, function, and deployment of embedded medical devices. Students will develop firmware using the Zephyr Realtime Operating System (RTOS) and will implement kernel timers, threads, work queues, state machines, kernel events, analog-to-digital conversion, pulse width modulation, serial communication protocols, Bluetooth, and software/ hardware debugging. Students will have hands-on experience with electronic hardware testing of flashed firmware.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

General Education Curriculum Codes
QS - (QS) Quantitative Studies

BME555 - Advances in Photonics (GE, IM)

Course Description

Overview of photonics techniques and their applications. The course will enhance students' understanding and knowledge of advanced techniques and introduce them to a variety of applications in photonics, the science and technology associated with interactions of light with matter. Photonics techniques include: advanced luminescence, Raman and SERS, optical coherence, advanced microscopy, near-field and confocal methods, remote sensing, and optical biosensing. Applications include: environmental sensing, medical diagnostics, assays using optical detection, optics in multispectral imaging, photonics and solar cells, and nanophotonics. Prerequisite: senior or graduate standing in BME or Chemistry.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
CHEM630 ADVANCES IN PHOTONICS

General Education Curriculum Codes
NW - (NW) Investigating Natural World: A&S Curriculum

BME561 - Synaptic Biology Synthetic Technology (AE: EL or MC; GE)

Course Description

This course will cover broad concepts in synaptic neurobiology, taught through the lens of the synthetic technologies driving each major advance. We begin with the quest to determine the whole-brain connectome, a challenge regarded by many as the wholly grail of modern neuroscience. We then explore the limits of understanding individual synapses, the fundamental substrate of learning and neural communication. By studying past and present technological advances, we hope to spark the next revolution in neuroscience, with implications for artificial intelligence and next-generation therapeutics. Area Designator(s): AE: EL or MC; GE.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

General Education Curriculum Codes
NS - (NS) Natural Sciences

BME562 - Biology by Design (GE, MC)

Course Description

Engineering biological systems emphasizing synthetic biology and the application of biological/chemical principles to the design of new biomolecules and cellular pathways. Review of primary scientific literature, highlighting contemporary research in this area, including artificial amino and nucleic acids, gene regulatory systems, directed molecular evolution, recombinant antibodies, novel biosynthesis pathways, cell communication, and the design of minimal organisms. Topics are presented with applications such as drug design, discovery, productions, regenerative medicine, and bioremediation. Prerequisite: Biomedical Engineering 244L. Organic chemistry or biochemistry suggested. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME563 - Transport Processes in HIV Transmission and Prevention (GE, BB, MC)

Course Description

Application of transport theory to analyze processes of HIV migration to target cells in the mucosa of the lower female reproductive tract. Analysis of the introduction, transport and bioactivity of molecules that inhibit these HIV-infection processes, including those acting topically (microbicides) and those introduced in a variety of drug delivery vehicles: semi-solid materials (gels, films) and solid materials (intravaginal rings). A succession of mathematical models will describe elements of the fundamental biology of this system and analyze the performance of specific products that act prophylactically against HIV infection. Prerequisite: Biomedical Engineering 307 or graduate student standing.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME564L - Genome Engineering Lab (GE, MC)

Course Description

CRISPR/Cas genome engineering technology has revolutionized the study and engineering of living systems. This course is designed for students interested in learning how to design, develop, and apply the most recent and advanced CRISPR/Cas9 systems for applications in diagnostics, cell line engineering, biopharmaceutical production, and gene and cell therapy. No previous experience in genome editing is required, but it is assumed that students have an introductory knowledge of molecular biology. Prerequisites: BME 307 or MC Area Core or graduate standing. (GE, MC)

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME565L - Environmental Molecular Biotechnology (GE, MC)

Course Description

Principles of genetics and recombinant DNA for environmental systems. Applications to include genetic engineering for bioremediation, DGGE, FISH, micro-arrays and biosensors. Laboratory exercises to include DNA isolation, amplification, manipulation and analysis. Prerequisites: Civil and Environmental Engineering 462L, Biology 20, Biology 201L, or graduate standing, or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
CEE661L ENV MOL BIOTECHNOLOGY

BME566 - Transport Phenomena in Cells and Organs (GE, MC)

Course Description
Applications of the principles of mass and momentum transport to the analysis of selected processes of biomedical and biotechnological interest. Emphasis on the development and critical analysis of models of the particular transport process. Topics include: reaction-diffusion processes, transport in natural and artificial membranes, dynamics of blood flow, pharmacokinetics, receptor-mediated processes and macromolecular transport, normal and neoplastic tissue. Prerequisite: Biomedical Engineering 307 or equivalent.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

BME567 - Biosensors (GE, IM, MC)

Course Description
Theory and applications of biosensors. Basic principles of interactions between analytes and bioreceptors and various transduction techniques: optical, electrochemical, ion-selective electrode-based, voltametric, conductometric, and mass-sensitive techniques as well as novel nanotechnology-based biosensing systems including nanosensors, plasmonic nanoprobes, quantum dots, carbon nanotubes, molecular beacons, and molecular sentinel systems. Applications in chemical, environmental, biological and medical sensing. Paired with Chemistry 601. Prerequisites: senior or graduate standing in BME or instructor's consent.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

BME570L - Introduction to Biomolecular Engineering (GE, BB, MC)

Course Description
Techniques of molecular biology through linked lectures and laboratory exercises with emphasis on molecular tools to manipulate and analyze DNA and RNA for specific molecular bioengineering applications. Lectures cover the genetic code, replication, transcription, translation, cloning vectors for E. coli, enzymatic manipulation of DNA, gene cloning, synthetic gene design and assembly, DNA sequencing, polymerase chain reaction, site-directed mutagenesis, overexpression and purification of recombinant proteins. Laboratory exercises, linked to lectures, cover cloning, mutagenesis and recombinant protein expression and purification. Prerequisites: BIO 201L or BME 260L or graduate standing in BME.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

BME574 - Modeling and Engineering Gene Circuits (GE, MC)

Course Description
This course discusses modeling and engineering gene circuits, such as prokaryotic gene expression, cell signaling dynamics, cell-cell communication, pattern formation, stochastic dynamics in cellular networks and its control by feedback or feedforward regulation, and cellular information processing. The theme is the application of modeling to explore 'design principles' of cellular networks, and strategies to engineer such networks. Students need to define an appropriate modeling project. At the end of the course, they're required to write up their results and interpretation in a research-paper style report and give an oral presentation. Prerequisites: Biomedical Engineering 260L or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
CBB574 GENE CIRCUITS

BME577 - Drug Delivery (GE, BB, MC)

Course Description
Introduction to drug delivery in solid tumors and normal organs (for example, reproductive organs, kidney, skin, eyes). Emphasis on quantitative analysis of drug transport. Specific topics include: physiologically-based pharmacokinetic analysis, microcirculation, network analysis of oxygen transport, transvascular transport, interstitial transport, transport across cell membrane, specific issues in the delivery of cells and genes, drug delivery systems, and targeted drug delivery. Prerequisite: Biomedical Engineering 307 and (Engineering 103L or Computer Science 201); or graduate standing.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

BME578 - Quantitative Cell and Tissue Engineering (GE, BB, MC)

Course Description
This course will serve as an overview of selected topics and problems in the emerging field of tissue engineering. General topics include cell sourcing and maintenance of differentiated state, culture scaffolds, cell-biomaterials interactions, bioreactor design, and surgical implantation considerations. Specific tissue types to be reviewed include cartilage, skin equivalents, blood vessels, myocardium and heart valves, and bioartificial livers. Prerequisite: Biomedical Engineering 302L or 307 or PhD student standing.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

BME580 - An Introduction to Biomedical Data Science (GE)

Course Description
This course will teach a combination of theory and application of biomedical data science principles using multi-scale biomedical data, including multi-omics, wearable sensor, and electronic health records data. Basic principles of data mining, exploratory data analysis, and statistics will be reviewed, and students will be introduced to supervised and unsupervised machine learning and model evaluation and selection methods. Methodology learned in classes will be applied in the assignments and class project to real world multi-omics, wearable sensor, and electronic health records data. Prerequisite: BME 244L or graduate standing. (GE)

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME590 - Special Topics in Biomedical Engineering

Course Description
Special subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Consent of instructor required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME590D - Special Topics with Discussion

Course Description
To be used as a generic course number for any special topics course with discussion sections. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

BME590DL - Special Topics with Lab and Discussion

Course Description
To be used as a generic course number for any special topics course with lab and discussion sections. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

BME590L - Special Topics with Lab

Course Description
To be used as a generic course number for any special topics course with lab sections. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

BME601L - Introduction to Neural Engineering

Course Description
Introduction to neural engineering with emphasis on the electrophysiology of neurons from a quantitative perspective. Topics include the ionic basis of action potentials, the Hodgkin-Huxley model, impulse propagation, source-field relationships, and an introduction to functional electrical stimulation. Not open to students who have taken BME 244L, 301L, 302L, 303L, or 307.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
4

Max Units:
4

BME609 - Optics and Photonics Seminar Series

Course Description
Weekly seminar on the current research topics in the field of optics and photonics.

Grading Basis
Credit / No Credit

Units

Min Units:
1

Max Units:
1

Crosslisted Courses
ECE549 OPTICS & PHOTONICS SEMINAR SER, PHYSICS549 OPTICS & PHOTONICS SEMINAR SER

BME644 - Physiology for Engineers

Course Description
This course will provide students with the fundamental knowledge of human physiology based on an understanding of how cells, tissues, organs, and organ systems function together in the human body. The physiology of human organ systems will be covered, with emphasis on the critical concept of homeostasis, cellular physiology, nervous systems, cardiovascular systems, renal physiology, and muscle system. Clinical scenarios will be incorporated throughout the course so that students can think critically about how disrupting the normal structure and function of the human body leads to disease processes. Open to graduate students only; students who have taken BME 244L are not eligible to take this course.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME671L - Signal Processing and Applied Mathematics

Course Description
This introductory applied mathematics course for graduate students covers the basics of linear systems theory including convolutions, Fourier Series, Fourier Transforms, and Laplace Transforms with emphasis on application to biomedical systems. Students will also get a basic understanding of how to program in MATLAB as they apply the course material to process sounds, images, and other biological signals. Not open to students who have taken BME 271.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
4

Max Units:
4

BME673L - Advanced Design and Manufacturing (GE, AE)

Course Description
Students must have exposure to 3DCAD and ideally have completed a capstone design project experience to enroll in this course. This course will expand and refine these skills in preparation for a career in product design and/or R&D. Design, prototyping and manufacturing skills will be discussed in class followed by a discrete project that will require use of these skills. Typically, each project will take place over the course of one or two weeks. A final project that will integrate several of the skills learned in the course will act as final examination for the course. Prerequisites: BME 474L or permission of instructor.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME690 - Advanced Topics in Biomedical Engineering

Course Description
Advanced subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Consent of instructor required.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

BME701S - BME Graduate Seminars

Course Description
This course is a weekly seminar required of all 2nd year BME PhD students. The seminar series will focus on preparation for the written portion of the preliminary exam with workshops and lectures, interleaved with seminars on career development. Writing instruction will include a seminar on creating clear and effective prose and discussions by BME faculty of each section of the document. Students will draft each section, and conduct peer-reviews in small groups. The career seminars with include methods to explore career options, networking, and internships. Students will be required to actively participate and provide feedback on seminars. More than two absences results in a failing grade.

Grading Basis
Credit / No Credit

Course Typically Offered
Spring Only

Units

Min Units:
0

Max Units:
0

BME702S - BME Graduate Seminars

Course Description
Two semester, weekly seminars series required of all BME graduate students. Students are exposed to the breadth of research topics in BME via seminars given by BME faculty, advanced graduate students, and invited speakers. At the end of each semester students are required to write a synopsis of the seminars attended. More than three unexcused absences will result in a failing grade.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall Only

Units

Min Units:
0

Max Units:
0

BME703S - Biomedical Engineering Distinguished Seminars

Course Description
This seminar course is designed for PhD students in Biomedical Engineering to engage with cutting-edge research through invited talks by renowned academics and industry leaders. Each semester, students will have the opportunity to attend seminars featuring experts from a wide range of disciplines, including biomaterials, neuroengineering, computational biology, translational imaging, and biophotonics. The seminar series fosters interdisciplinary collaboration, enhances scientific communication skills, and provides exposure to novel research methodologies and innovations in the biomedical field. Attendance is mandatory for enrolled students, and active participation in post-seminar discussions is encouraged.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
1

BME705L - Biotech Design I

Course Description
This course is the first semester of a two semester biochemical engineering design course sequence on biotechnology. It is a team focused project based course. Student teams take on real world problems and evaluate the commercial and technical potential of biotechnological solutions. The first semester course is primarily conceptual (on paper) design which students can then build and test in the second semester design course, Biotech Design II. Previous projects have included the design of diagnostics, small molecule and protein drugs, cell based therapies, CRISPR based therapeutics as well as novel bioprocesses.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME706L - Biotech Design II

Course Description
This is the second semester of a two semester biochemical engineering design course sequence on biotechnology for those interested in the pharmaceuticals and broader biotechnology industries. In this second semester, student teams will design, build and test a biochemical process for the production of desired biochemical product including pharmaceuticals and other small molecule precursors.The course will cover basic principles of product/process design and commercialization including project management, market and economic constraints, regulatory considerations and an intellectual property assessment. Prerequisite: BME 705L.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME711S - Biological Engineering Seminar Series (CBIMMS and CBTE)

Course Description
Seminar series featuring in alternate weeks invited speakers and pre-seminar discussions. Research topics in biological engineering, with emphasis on bioinspired materials and materials systems, biomolecular, and tissue engineering. Enrollment is required of all BIMMS and BTE certificate program students in their first and second year. Open to others for credit or audit. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
1

Max Units:
1

Crosslisted Courses
ME717S BIOLOGICAL ENGINEERING SEM

BME712S - Biological Engineering Seminar Series (CBIMMS and CBTE)

Course Description
Seminar series featuring in alternate weeks invited speakers and pre-seminar discussions. Research topics in biological engineering, with emphasis on bioinspired materials and materials systems, biomolecular, and tissue engineering. Enrollment is required of all BIMMS and BTE certificate program students in their first and second year. Open to others for credit or audit. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
1

Max Units:
1

Crosslisted Courses
ME718S BIOLOGICAL ENGINEERING SEM

BME713S - QBio Seminar Series

Course Description
Frontiers in Quantitative Biodesign is an advanced-level, interdisciplinary seminar series designed to introduce students to the latest cutting-edge technologies and techniques in the field of quantitative biodesign. It aims to give students an in-depth understanding of how mathematical and computational approaches can be harnessed to accelerate, de-risk, and optimize the design and engineering of biological systems and to create tools to control biological processes.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
1

BME728S - Teaching Seminar for New Teaching Assistants

Course Description
This 3 credit seminar is for BME PhD students concurrently serving as a TA for the first time. It is mandatory for those entering the program in Fall 2015 and optional for all BME PhD students who entered the program before Fall 2015. Throughout this course, students will attend a series of seminars (5 minimum) designed to improve pedagogical training and support for teaching assistants. Students will practice concepts learned in the seminars during TAship. Teaching assistants will receive feedback through performance evaluations by the professor. Evaluations will be given twice per semester. The teaching assistants also complete an activity log to document time spent.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME729S - Teaching Seminar for Repeat Teaching Assistants

Course Description
This 3 credit seminar is for BME PhD students concurrently serving as a TA for the second time or later. It is mandatory for those entering the program in Fall 2015 and optional for all BME PhD students who entered the program before Fall 2015. Throughout this course, students will participate in mentoring activities designed to improve pedagogical training and support for teaching assistants. Students will practice concepts learned in the seminars during TAship. Teaching assistants will receive feedback through performance evaluations by the professor. Evaluations will be given twice per semester. The teaching assistants also complete an activity log to document time spent.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME733 - Experimental Design and Biostatistics for Basic Biomedical Scientists

Course Description
The use and importance of statistical methods in laboratory science, with an emphasis on the nuts and bolts of experimental design, hypothesis testing, and statistical inference. Central tendency and dispersion, Gaussian and non-Gaussian distributions, parametric and nonparametric tests, uni- and multivariate designs, ANOVA and regression procedures. Ethical issues in data handling and presentation. Student presentations in addition to formal lectures. Intended for third-year graduate students. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
2

Max Units:
2

Crosslisted Courses
PHARM733 EXPERIMENT DESIGN & STATISTICS, NEUROBIO733 EXPERIMENT DESIGN & STATISTICS, CMB733 EXPERIMENT DESIGN & STATISTICS, MOLCAN733 EXPERIMENT DESIGN & STATISTICS

BME760L - Medical Neuroscience and Clinical Human Neuroanatomy

Course Description
Explore the structure, functional organization, and neurobiology of the human central nervous system, its integrative actions, and the impairments of sensation, action and cognition that accompany injury or disease. Features a variety of instructional methods, including hands-on examination and dissection of human brain specimens, asynchronous video tutorials, live seminars with clinical experts, patient-interviews, and cases studies. Employs team-based learning, with graduate students integrated into teams of first-year medical students for real-time problem-solving and discovery. Requires general knowledge of cell and molecular biology, mammalian physiology and anatomy.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
4

Max Units:
4

Crosslisted Courses
NEUROSCI760L MEDICAL NEUROSCIENCE, EVANTH760L MEDICAL NEUROSCIENCE

BME771 - Bioconjugation in drug biomaterials and drug delivery systems

Course Description
Bioconjugation chemistry is the science of coupling biomolecules for a wide range of applications. For example, proteins may be coupled with one polymer to enhance its stability in serum or polymers may be coupled to each other to form hydrogels. A wide variety of bioconjugates are used in the delivery of pharmaceuticals, in sensors, in medical diagnostics, and in tissue engineering. Basic concepts of chemical ligation, including the choice and design of conjugate linkers depending on the type of biomolecule and desired application, such as degradable versus nondegradable linkers. The class will focus on biomaterial and drug delivery strategies.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME773L - Design Health 1: Discover

Course Description
First semester of a 3 semester design course sequence (BME 773L, BME 774L, BME 775L) for graduate students. Students will expand on their formal engineering design principles knowledge by applying it to identify and research a need drawn from the Duke Hospital/medical personnel, local companies and organizations around Duke University. Students will develop and determine design feasibility for a device, system, material, or process subject to real world constraints. Recommended prerequisite: BME capstone design experience.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

BME774L - Design Health 2: Design

Course Description
Second semester of a 3 semester design course sequence (BME 773L, 774L,775L) for graduate students. Students will iterate their design solution drawn from the Duke Hospital/medical personnel, local companies and organizations around Duke University. Students will develop and determine design feasibility for a device, system, material, or process subject to real world constraints. Prerequisite: BME 773L

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

BME775L - Design Health 3: Deliver

Course Description
Third semester of a 3 semester design course sequence (BME 773L, BME 774L and BME 775L) for graduate students. Students will expand on their formal engineering design principles knowledge by applying it to identify and research a need drawn from the Duke Hospital/medical personnel, local companies and organizations around Duke University. Students will develop and determine design feasibility for a device, system, material, or process subject to real world constraints. Prerequisite: BME capstone design experience, and have already taken BME 773L and BME 774L.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME788 - Invention to Application: Healthcare Research Commercialization

Course Description
Interdisciplinary teams of students from engineering, medical science, business, and medicine work together to understand and evaluate the commercial potential of Duke faculty research innovations and develop a comprehensive research translation and business plan for one chosen opportunity. Learning includes understanding technology, product development, marketing, finance, regulatory requirements, and reimbursement. In addition to weekly lectures, students are mentored in this real world experience by a team including technology transfer experts, venture capitalists, researchers, physicians, and entrepreneurs. Prerequisites: none. Consent of instructor required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME789 - Internship in Biomedical Engineering

Course Description
Student gains practical biomedical engineering experience by taking a job in industry, and writing a report about this experience. Requires prior consent from the student's advisor and from the director of graduate studies. May be repeated with consent of the advisor and the director of graduate studies. Credit/no credit grading only.

Grading Basis
Credit / No Credit

Units

Min Units:
1

Max Units:
3

BME790 - Advanced Topics for Graduate Students in Biomedical Engineering

Course Description
Advanced subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Consent of instructor required.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

BME790L - Advanced Topics with the Lab for Graduate Students in Biomedical Engineering

Course Description
Advanced subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Consent of instructor required. Includes laboratory component.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

BME791 - Graduate Independent Study

Course Description
First Independent Study course in advanced study and research areas of biomedical engineering. Approval of adviser is required.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

BME792 - Continuation of Graduate Independent Study

Course Description
Second independent study in advanced study and research areas of biomedical engineering. Approval of adviser is required.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

BME803 - Advanced Computational Neuroengineering

Course Description
This advanced course for PhD students covers the fundamentals of computational modeling of neurons and neuronal circuits and the decoding of information from populations of spike trains. Topics include: integrate and fire neurons, spike response models, homogeneous and inhomogeneous Poisson processes, neural circuits, Weiner (optimal) adaptive filters, neural networks for classification, population vector coding and decoding. Programming assignments and projects will be carried out using Python.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME804 - Developments in Neural Engineering

Course Description
The objective of this course is to provide in depth exposure to and critical analysis of current topics in neural engineering. Students will develop skills of critical reading and analysis, data synthesis and presentation, and discussion leadership. The course will serve the secondary purpose of providing exposure of our neural engineering faculty and students to leaders in the field. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

BME844 - Advanced Ultrasonic Imaging

Course Description
This course provides students with a mathematical basis of ultrasonic imaging methods. Topics include K-space, descriptions of ultrasonic imaging, ultrasonic beam-former design, tissue motion and blood flow imaging methods, and novel ultrasonic imaging methods. Students conduct extensive simulations of ultrasonic imaging methods. Prerequisite: Biomedical Engineering 333.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

BME845 - Elasticity Imaging

Course Description
Theory and practical implementation of elasticity imaging techniques, including static, dynamic, physiologic and acoustic radiation force based methods; continuum mechanics; wave propagation in soft tissues; algorithms for quantifying wave speed; and material models employed in elasticity reconstruction methods (linearity, anisotropy, and viscoelasticity); simulations tools employed during system development will be introduced, including FEM modeling approaches and ultrasonic imaging simulation tools. Assignments include weekly readings and literature reviews, weekly homework (simulations/FEM modeling tools), and a final project. Prerequisites: BME 542 and BME 530 or instructor permission.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

BME848L - Radiology in Practice

Course Description
Designed to complement Biomedical Engineering 333 Modern Diagnostic Imaging Systems. Review and real-life exercises on principles of modern medical imaging systems with emphasis on the engineering aspects of image acquisition, reconstruction and visualization, observations of imaging procedures in near clinical settings, and hands-on experience with the instruments. Modalities covered include ultrasound, CT, MRI, nuclear medicine and optical imaging. Prerequisite: Biomedical Engineering 333 or equivalent.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
MEDPHY738 RADIOLOGY IN PRACTICE

BME890 - Advanced topics for PhD students

Course Description
Advanced subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Consent of instructor required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME899 - Special Readings in Biomedical Engineering

Course Description
Individual readings in advanced study and research areas of biomedical engineering. Approval of director of graduate studies required.

Grading Basis
Graded

Units

Min Units:
1

Max Units:
3

BME500-1 - Regulation and Reimbursement of Medical Products: Practice and Policy

Course Description
The objective of the course is to give a practical overview of the current regulatory and reimbursement landscape for medical products (drugs, devices, and biologics), as well as understanding of current issues that may influence existing and/or future regulatory and reimbursement practices and policies. The focus will be primarily on US regulation and reimbursement policy, but international context will be included as appropriate. Students can expect to gain basic understanding of how drugs, devices, and biological products are tested and regulated as well as the multiple stakeholders involved in the purchase and reimbursement of medical products. Area Designator(s): GE

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
HLTHPOL540 REIMBURSEMENT MED PROD

BME500-2 - Quality Management Systems for Biomedical Engineers

Course Description
The course establishes industry best-practice procedures and methods for the development of medical devices within a regulated environment such as that required by the FDA in 21CFR820. Specific key elements of a regulatory submission will be generated as the course progresses through elements of specification, risk management, verification and validation. Alongside understanding and exercising key principles of Quality Management as applied to both design & manufacture, students will also learn how to operate within typical industry systems and organizational structures. Area Designator: GE

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

BME590-1 - Special Topics in Biomedical Engineering

Course Description
Special subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Consent of instructor is required.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1.5

Max Units:
1.5

BME590L-1 - Special Topics with Lab

Course Description
Half-credit special topics course.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1.5

Max Units:
1.5

BME790S-1 - Advanced Topics for Graduate Students in Biomedical Engineering

Course Description
Advanced subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Consent of instructor required.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
1

BME791-1 - Graduate Independent Study

Course Description
First Independent Study course in advanced study and research areas of biomedical engineering.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
1

CEE501 - Applied Mathematics for Engineers

Course Description
Advanced analytical methods of applied mathematics useful in solving a wide spectrum of engineering problems. Applications of linear algebra, calculus of variations, the Frobenius method, ordinary differential equations, partial differential equations, and boundary value problems. Prerequisite: MATH 353 or equivalent and undergraduate courses in solid and/or fluid mechanics, or graduate student standing in an engineering program.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

CEE506 - Environmental Spatial Data Analysis

Course Description
Environmental Spatial Data Analysis (ESDA) provides an introduction on how to leverage and analyze geospatial data using Python. The topics that are covered include geospatial numerical arrays, geostatistics, digital cartography, classification, regression, spectral analysis, clustering, terrain analysis, bayesian statistics, and dimensionality reduction. Prerequisite: EGR 238L or graduate standing.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

CEE511 - Construction Management

Course Description
This course is a broad overview of the roles and responsibilities of the construction management engineer. Included in this is an examination of: Project Management Planning, Cost Management, Time Management, Quality Management, Contract Administration, and Safety Management. Topics covered will include: defining the responsibilities and management structure of the project management team, organizing and leading by implementing project controls, defining roles and responsibilities and developing communication protocols, and identifying elements of project design and construction likely to give rise to disputes and claims. Field trips.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE520 - Continuum Mechanics

Course Description
Tensor fields and index notation. Analysis of states of stress and strain. Conservation laws and field equations. Constitutive equations for elastic, viscoelastic, and elastic-plastic solids. Formulation and solution of simple problems in elasticity, viscoelasticity, and plasticity.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

CEE521 - Elasticity (GE, BB)

Course Description
Linear elasticity will be emphasized including concepts of stress and strain as second order tensors, equilibrium at the boundary and within the body, and compatibility of strains. Generalized solutions to two and three dimensional problems will be derived and applied to classical problems including torsion of noncircular sections, bending of curved beams, stress concentrations and contact problems. Applications of elasticity solutions to contemporary problem in civil and biomedical engineering will be discussed. Prerequisites: Engineering 201L; Mathematics 353.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
BME526 ELASTICITY

CEE525 - Wave Propagation in Elastic and Poroelastic Media

Course Description
Basic theory, methods of solution, and applications involving wave propagation in elastic and poroelastic media. Analytical and numerical solution of corresponding equations of motion. Linear elasticity and viscoelasticity as applied to porous media. Effective medium, soil/rock materials as composite materials. Gassmann's equations and Biot's theory for poroelastic media. Stiffness and damping characteristics of poroelastic materials. Review of engineering applications that include NDT, geotechnical and geophysical case histories. Prerequisite: Mathematics 353, graduate standing, or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE530 - Introduction to the Finite Element Method

Course Description
Investigation of the finite element method as a numerical technique for solving linear ordinary and partial differential equations, using rod and beam theory, heat conduction, elastostatics and dynamics, and advective/diffusive transport as sample systems. Emphasis placed on formulation and programming of finite element models, along with critical evaluation of results. Topics include: Galerkin and weighted residual approaches, virtual work principles, discretization, element design and evaluation, mixed formulations, and transient analysis. Prerequisites: a working knowledge of ordinary and partial differential equations, numerical methods, and programming in FORTRAN or MATLAB.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ME524 FINITE ELEMENT METHOD

CEE531 - Finite Element Methods for Problems in Fluid Mechanics

Course Description
An extensive introduction to finite element methods for fluid flow problems, covering methods for general transport problems, the compressible Euler and Navier-Stokes equations, the incompressible Navier-Stokes equations, and subsurface flows in porous media. Knowledge on the foundations of numerical analysis and finite elements (i.e., structural mechanics or thermal transfer problems) is advisable but not a prerequisite. Taking this course in conjunction with CEE 530 (254) 'Introduction to the Finite Element Method', CEE 630 (255) 'Nonlinear Finite Element Analysis', or CEE 635 (256) 'Computational Methods for Evolving Discontinuities' should also be considered by students.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE551 - Risk and Resilience Engineering

Course Description
Risks to engineered systems, human life, the environment, and economic performance have long been important considerations in all types of engineering. Probabilistic risk analysis provides a means for assessing and mitigating these risks. However, the modern world also requires systems that exhibit resilience, by assimilating new information, adapting to change, and performing in unexpected conditions. This course covers the theory and applications of risk and resilience engineering, including quantification, interpretation, design, and management. Introductory level knowledge in probability is assumed.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

CEE560 - Environmental Transport Phenomena

Course Description
Principles of mathematical modeling of environmental systems. Mass balances, ideal reactor models for lakes, rivers, atmospheric systems, and population dynamics. Derivation of Navier-Stokes equations, advective diffusion equation, mass transfer and fluid dynamics. Conservation principles in the atmosphere and bodies of water, fundamental equations for transport in the atmosphere and bodies of water, scaling principles, simplification, turbulence, turbulent transport and boundary layers.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

CEE561L - Environmental Aquatic Chemistry

Course Description
Principles of chemical equilibria and kinetics as applied in environmental engineering and science processes. Topics include acid-base equilibrium, the carbonate system, metal complexation, oxidation/reduction reactions, mineral phase solubility and surface sorption. Applied environmental systems include water treatment, soil remediation, air pollution and green engineering. Graduate-level requirements include specific laboratory work and written assignments. Open to graduate students; instructor consent required for undergraduates. Not open to students who have taken CEE 461L.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENVIRON542L ENVIRONMENTAL AQUATIC CHEM

CEE562L - Applied Biological Principles and Processes in Environmental Engineering

Course Description
Fundamentals of microbiology as it relates to biological environmental engineering processes. Topics include microbial metabolism, microbial kinetics and stoichiometry, and bioreactor models. Applications include unit processes in wastewater treatment, bioremediation, bioreactors, waste to bioenergy. Laboratory included. Graduate-level requirements include a term paper and/or a project. Open to graduate students; instructor consent required for undergraduates. Not open to students who have taken CEE 462L.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

CEE563 - Chemical Fate of Organic Compounds

Course Description
This course will review environmental organic chemistry basics with a focus on contaminant chemistry. We will discuss quantitative processes used in predicting the fate and distribution of organic chemicals in the environment with regards to equilibrium/thermodynamics and some kinetic considerations. Topics include: equilibrium partitioning among air, water, sediments and biological tissues; factors affecting bioaccumulation and biomagnification; processes influencing the ultimate fate of organic contaminants in rivers and lakes; and processes influencing global transport. Prerequisites: University-level general chemistry and organic chemistry within last four years.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENVIRON540 CHEM FATE ORG COMPOUNDS

General Education Curriculum Codes
NW - (NW) Investigating Natural World: A&S Curriculum

CEE563D - Chemical Fate of Organic Compounds

Course Description
Equilibrium, kinetic, and analytical approaches applied to quantitative description of processes affecting the distribution and fate of anthropogenic and natural organic compounds in surface and ground waters, including chemical transfers between air, water, soils/sediments, and biota; and thermochemical and photochemical transformations. The relationships between organic compound structure and environmental behavior will be emphasized. Sampling, detection, identification, and quantification of organic compounds in the environment. Prerequisite: university-level general chemistry and organic chemistry within last four years.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENVIRON540D CHEM FATE ORG COMPOUNDS

CEE564 - Physical Chemical Processes in Environmental Engineering

Course Description
Theory and design of fundamental and alternative physical and chemical treatment processes for pollution remediation. Reactor kinetics and hydraulics, gas transfer, adsorption, sedimentation, precipitation, coagulation/flocculation, chemical oxidation, disinfection. Prerequisites: introductory environmental engineering, chemistry, graduate standing, or permission of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

CEE565 - Environmental Analytical Chemistry

Course Description
This course covers the fundamentals and applications of analytical chemistry as applied to detection, identification, and quantification of anthropogenic contaminants in environmental samples including air, water, soil, sediment, and biota. The topics include both sample preparation methods (i.e. wet chemistry) and instrumental analysis (e.g. mass spectrometry, chromatography, and optical spectroscopy). Particular emphasis is placed on current advancements in measurement science as applied to environmental chemistry. The material includes both theoretical and practical aspects of environmental analysis. Prerequisite: CHEM 131 or CHEM 151L or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENVIRON566 ENVIRON. ANALYTICAL CHEM.

CEE566 - Environmental Microbiology

Course Description
Fundamentals of microbiology and biochemistry as they apply to environmental engineering. General topics include cell chemistry, microbial metabolism, bioenergetics, microbial ecology and pollutant biodegradation. Prerequisite: Civil and Environmental Engineering 462L or graduate standing or consent of the instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE574 - Remote Sensing in Coastal Environments

Course Description
Introduction to the field of remote sensing and image processing with focus on applications to coastal monitoring and currently open research questions. Students will acquire an operational knowledge of various remote-sensing tools and data types, with emphasis on their application in coastal areas. Content will include theory, in-class laboratory exercises, and projects with environmental applications. Prerequisite: introductory or AP physics preferred or permission of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENVIRON530 REMOTE SENSING COASTAL ENV, ECS530 REMOTE SENSING COASTAL ENV

General Education Curriculum Codes
NS - (NS) Natural Sciences, QS - (QS) Quantitative Studies

CEE575 - Air Pollution Engineering

Course Description
Introduction to air pollutants. Upon completion, students will have a knowledge of which air pollutants are of concern, their source, fate, atmospheric transport and transformation and policies developed to help manage the problem. Topics include: air pollutants of importance, air pollution impacts, sources of air pollutants, atmospheric transport (including dispersion and deposition), atmospheric chemistry, aerosol chemistry and physics, control strategy development and air pollution management. Additionally, the course covers indoor air pollution with an emphasis on issues related to airborne viral disease emission, transport, and infection. Prerequisite: Chemistry 20, 21, or 101DL, or graduate standing.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE581 - Pollutant Transport Systems

Course Description
Distribution of pollutants in natural waters and the atmosphere; diffusive and advective transport phenomena within the natural environment and through artificial conduits and storage/treatment systems. Analytical and numerical prediction methods. Prerequisite: Civil and Environmental Engineering 301L and Mathematics 353, or equivalents.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE584 - Physical Hydrology

Course Description
This course provides a process-based introduction to the different components of the terrestrial hydrologic cycle including precipitation, evapotranspiration, interception, snow hydrology, open-channel flow, flows in porous media, infiltration, and groundwater. An overview of catchment hydrology, global hydrology, frequency analysis, urban hydrology, and ecohydrology are also be discussed. Prerequisite: CEE 463L or graduate standing.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

CEE621 - Plasticity

Course Description
Inelastic behavior of soils and engineering materials. Yield criteria. Flow rules. Concepts of perfect plasticity and plastic hardening. Methods of rigid-plasticity. Limit analysis. Isotropic and kinematic hardening. Plastic softening. Diffused damage. Thermo-plasticity. Visco-plasticity. Prerequisite: Civil and Environmental Engineering 520 or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE622 - Fracture Mechanics

Course Description
Theoretical concepts concerning the fracture and failure of brittle and ductile materials. Orowan and Griffith approaches to strength. Determination of stress intensity factors using compliance method, weight function method, and numerical methods with conservation laws. Cohesive zone models, fracture toughness, crack growth stability, and plasticity. Prerequisites: Civil and Environmental Engineering 520, or instructor consent.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE623 - Mechanics of Composite Materials

Course Description
Theory and application of effective medium, or homogenization, theories to predict macroscopic properties of composite materials based on microstructural characterizations. Effective elasticity, thermal expansion, moisture swelling, and transport properties, among others, are presented along with associated bounds such as Voigt/Reuss and Hashin-Shtrikman. Specific theories include Eshelby, Mori-Tanaka, Kuster-Toksoz, self-consistent, generalized self-consistent, differential method, and composite sphere and cylinder assemblages. Tensor-to-matrix mappings, orientational averaging, and texture analysis. Composite laminated plates, environmentally induced stresses, and failure theories. Prerequisite: Civil and Environmental Engineering 520 or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE625 - Intermediate Dynamics: Dynamics of Very High Dimensional Systems

Course Description
Dynamics of very high dimensional systems. Linear and nonlinear dynamics of a string as a prototypical example. Equations of motion of a nonlinear beam with tension. Convergence of a modal series. Self-adjoint and non-self-adjoint systems. Orthogonality of modes. Nonlinear normal modes. Derivation of Lagrange's equations from Hamilton's Principle including the effects of constraints. Normal forms of kinetic and potential energy. Component modal analysis. Asymptotic modal analysis.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ME541 INTERMEDIATE DYNAMICS

CEE626 - Energy Flow and Wave Propagation in Elastic Solids

Course Description
Derivation of equations for wave motion in simple structural shapes: strings, longitudinal rods, beams and membranes, plates and shells. Solution techniques, analysis of systems behavior. Topics covered include: nondispersive and dispersive waves, multiple wave types (dilational, distortion), group velocity, impedance concepts including driving point impedances and moment impedances. Power and energy for different cases of wave propagation. Prerequisites: Engineering 244L and Mathematics 353 or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ME543 ENERGY FLOW & WAVE PROPAGATION

CEE627 - Linear System Theory

Course Description
Construction of continuous and discrete-time state space models for engineering systems, and linearization of nonlinear models. Applications of linear operator theory to system analysis. Dynamics of continuous and discrete-time linear state space systems, including time-varying systems. Lyapunov stability theory. Realization theory, including notion of controllability and observability, canonical forms, minimal realizations, and balanced realizations. Design of linear feedback controllers and dynamic observers, featuring both pole placement and linear quadratic techniques. Introduction to stochastic control and filtering. Prerequisites: Electrical and Computer Engineering 382 or Mecahnical Engineering 344, or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ME627 LINEAR SYSTEM THEORY

CEE628 - Uncertainty Quantification in Computational Science and Engineering

Course Description
This course is concerned with the modeling, identification, and propagation of model and parametric uncertainties in computational science and engineering. The aim is to provide decision makers, engineers and scientists with predictions endowed with measures of confidence. In practice, the randomness introduced within the modeling framework can reflect intrinsic stochasticity or some lack of knowledge. The covered material finds applications in a broad range of fields, from the modeling of materials and complex systems to robust design optimization. The course is oriented towards the understanding and implementation of state-of-the-art techniques for applied or fundamental research projects.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

CEE630 - Nonlinear Finite Element Analysis

Course Description

Formulation and solution of nonlinear initial/boundary value problems using the finite element method. Systems include nonlinear heat conduction/diffusion, geometrically nonlinear solid and structural mechanics applications, and materially nonlinear systems (for example, elastoplasticity). Emphasis on development of variational principles for nonlinear problems, finite element discretization, and equation-solving strategies for discrete nonlinear equation systems. Topics include: Newton-Raphson techniques, quasi-Newton iteration schemes, solution of nonlinear transient problems, and treatment of constraints in a nonlinear framework. An independent project, proposed by the student, is required. Prerequisite: Civil and Environmental Engineering 530/Mechanical Engineering 524, or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ME525 NONLIN FIN ELEMENT ANALY

CEE642 - Environmental Geomechanics

Course Description

The course addresses engineered and natural situations, where mechanical and hydraulic properties of soils and rocks depend on environmental (thermal chemical, biological) processes. Experimental findings are reviewed, and modeling of coupled thermo-mechanical, chemo-mechanical technologies are reviewed.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE643 - Environmental and Engineering Geophysics

Course Description

Use of geophysical methods for solving engineering and environmental problems. Theoretical frameworks, techniques, and relevant case histories as applied to engineering and environmental problems (including groundwater evaluation and protection, siting of landfills, chemical waste disposals, roads assessments, foundations investigations for structures, liquefaction and earthquake risk assessment). Introduction to theory of elasticity and wave propagation in elastic and poroelastic media, electrical and electromagnetic methods, and ground penetrating radar technology. Prerequisite: Mathematics 353 or Physics 152L, or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE647 - Buckling of Engineering Structures

Course Description

An introduction to the underlying concepts of elastic stability and buckling, development of differential equation and energy approaches, buckling of common engineering components including link models, struts, frames, plates, and shells. Consideration will also be given to inelastic behavior, postbuckling, and design implications.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ME527 BUCKLING EGR STRUCTURES

CEE649 - Structural Engineering Project Management

Course Description
Apply project management tools and skills to a structural engineering design project. Implement changes in schedule, budget, and changing client and/or regulatory climate. Work with a design team of undergraduate students. Prerequisites: not open to students who have had Civil and Environmental Engineering 429, 469, or 679. Consent of instructor required.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

CEE661L - Environmental Molecular Biotechnology (GE, MC)

Course Description
Principles of genetics and recombinant DNA for environmental systems. Applications to include genetic engineering for bioremediation, DGGE, FISH, micro-arrays and biosensors. Laboratory exercises to include DNA isolation, amplification, manipulation and analysis. Prerequisites: Civil and Environmental Engineering 462L, Biology 20, Biology 201L, or graduate standing, or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
BME565L ENV MOL BIOTECHNOLOGY

CEE666 - Aquatic Geochemistry

Course Description
Geochemistry of the water-solid interface of soils, minerals, and particles in earth systems. Topics will cover the chemical composition of soils, geochemical specalation, mineral weathering and stability, sorption and ion exchange, soil redox processes, and chemical kinetics at environmental surfaces. Prerequisites: CEE 461L or CEE 561L/ENVIRON 542L or permission of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENVIRON666 AQUATIC GEOCHEM

CEE667 - Chemical Transformation of Environmental Contaminants

Course Description

Mechanisms and principles underlying organic contaminant transformations in the ambient environment. Topics include hydrolysis, oxidation/reduction, direct and indirect photolysis, and reactions with disinfectant chemicals. Reactions will be considered in context of both natural (e.g. surface water and cloudwater) and engineered (e.g. drinking water, wastewater, and groundwater remediation) systems. Approaches will include both qualitative (reaction mechanism and product identification) as well as quantitative (reaction kinetics and stoichiometry) aspects of environmental reaction chemistry. Prerequisites: CEE 563/ENVIRON 540 or one semester of organic chemistry.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENVIRON667 CHEM TRANSFORM OF ENV CONTAM

CEE675 - Introduction to the Physical Principles of Remote Sensing of the Environment

Course Description

The course provides an overview of the radiative transfer principles used in remote-sensing across the electromagnetic spectrum using both passive and active sensors. Special focus is placed on the process that leads from theory to the development of retrieval algorithms for satellite-based sensors, including post-processing of raw observations and uncertainty analysis. Students carry on three hands-on projects (Visible and Thermal Infrared, Active Microwave, and Passive Microwave). Background in at least one of the following disciplines is desirable: radiation transfer, signal processing, and environmental physics (Hydrology, Geology, Geophysics, Plant Biophysics, Soil Physics). Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE679 - Environmental Engineering Project Management

Course Description

Apply project management tools and skills to an environmental engineering design project. Implement changes in schedule, budget, and changing client and/or regulatory climate. Work with a design team of undergraduate students. Consent of instructor required. Prerequisites: not open to students who have had Civil and Environmental Engineering 429, 469, or 649.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

CEE683 - Groundwater Hydrology and Contaminant Transport

Course Description

Review of surface hydrology and its interaction with groundwater. The nature of porous media, hydraulic conductivity, and permeability. General hydrodynamic equations of flow in isotropic and anisotropic media. Water quality standards and contaminant transport processes: advective-dispersive equation for solute transport in saturated porous media. Analytical and numerical methods, selected computer applications. Deterministic versus

stochastic models. Applications: leachate from sanitary landfills, industrial lagoons and ponds, subsurface wastewater injection, monitoring of groundwater contamination. Conjunctive surface-subsurface models. Prerequisite: Civil and Environmental Engineering 301L, or graduate standing, or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

CEE684 - Physical Hydrology and Hydrometeorology

Course Description
The objective of this course is to introduce and familiarize graduate students with the fundamental physical processes in Hydrology and Hydrometeorology that control and modulate the pathways and transformations of water in the environment. The content of the course will be strongly oriented toward providing students with a specific basis for quantitative analysis of the terrestrial water cycle including land-atmosphere interactions and clouds and precipitation (rain and snow) processes. The course should be of interest to undergraduate and graduate students interested in Environmental Science and Engineering, and Atmospheric and Earth Sciences.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

CEE688 - Turbulence 1

Course Description
This is an introductory course on the subject of turbulence in fluids. The focus is on understanding the fundamental physical processes and mechanisms governing the behavior of turbulent flows. The course covers the following - overview of physical and mathematical properties of Navier-Stokes equation; kinematics, dynamics and energetics of turbulent flows; Kolmogorov theories of turbulence; Richardson energy cascade; wall-bounded turbulent flows; particle dispersion, clustering and collisions in turbulent flows. Prerequisite: ((CEE 301L or ME 336L) and Mathematics 353) or graduate standing. Recommended prerequisite: an introductory course on fluid mechanics, and a course on differential equations.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ME634 TURBULENCE 1

CEE690 - Advanced Topics in Civil and Environmental Engineering

Course Description
A course on an advanced topic within the civil and environmental engineering department.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
1

Max Units:
3

CEE691 - Independent Study: Advanced Topics in Civil and Environmental Engineering

Course Description

Study arranged on an advanced subject relating to programs within the civil and environmental engineering department tailored to fit the requirements of individuals or small groups. Consent of director of graduate studies required.

Grading Basis

Graded

Course Typically Offered

Fall Only

Units

Min Units:

1

Max Units:

3

CEE692 - Independent Study: Advanced Topics in Civil and Environmental Engineering

Course Description

Study arranged on an advanced subject relating to programs within the civil and environmental engineering department tailored to fit the requirements of individuals or small groups. Consent of director of graduate studies required.

Grading Basis

Graded

Course Typically Offered

Spring Only

Units

Min Units:

1

Max Units:

3

CEE701 - Graduate Colloquium

Course Description

Current topics in civil and environmental engineering theory and practice. Weekly seminar series.

Grading Basis

Credit / No Credit

Course Typically Offered

Fall Only

Units

Min Units:

0

Max Units:

0

CEE702 - Graduate Colloquium

Course Description

Current topics in civil and environmental engineering theory and practice. Weekly seminar series.

Grading Basis

Credit / No Credit

Course Typically Offered

Spring Only

Units

Min Units:

0

Max Units:

0

CEE761 - Hydrologic and Environmental Data Analysis

Course Description
Course will focus on acquisition of skills necessary to extract information from observations of hydrological and environmental processes, connect the extracted information with the physical processes generating the data, and estimate physical quantities at ungauged location/times. Emphasis on process understanding via data analysis techniques. Applications used as a way to understand the general concepts, with examples drawn from water science. Prerequisites: Basic computer skills, Algebra, Calculus are required. Experience with computational software (e.g. Matlab or R) is helpful but not required.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENVIRON722 HYDROLOGIC DATA ANALYSIS, ECS722 HYDROLOGIC DATA ANALYSIS

CEE780 - Internship

Course Description
Student gains practical experience in civil and environmental engineering by taking a job in industry, and writes a report about this experience. Requires prior consent from the student's advisor and from the director of graduate studies.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
1

CEE890 - Advanced Topics in Civil & Environmental Engineering

Course Description
A course on an advanced topic within the civil and environmental engineering department.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
3

CEE891 - Independent Study: Advanced Topics in CEE

Course Description
Special individual readings in a specific area of study in civil and environmental engineering. Approval of director of graduate studies required.

Grading Basis
Graded

Units

Min Units:
1

Max Units:
3

CEE892 - Independent Study: Advanced Topics in CEE

Course Description
Special individual readings in a specific area of study in civil and environmental engineering. Approval of director of graduate studies required.

Grading Basis
Graded

Units

Min Units:
1

Max Units:
3

CYBERSEC500 - Introduction to Cybersecurity Perspectives

Course Description
Introduction to Cybersecurity Perspectives will introduce or re-acquaint the students with the cybersecurity challenges organizations face today, providing an overview of the domains, concepts and elements needed to provide the foundation for a well-performing cyber organization.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

CYBERSEC501 - Seminar

Course Description
Current topics in applied cybersecurity. Weekly seminar series.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall Only

Units

Min Units:
0

Max Units:
0

CYBERSEC502 - Cybersecurity and Interdisciplinary Law/Ethics/Policy/Privacy Considerations

Course Description
This course will introduce students to the legal, regulatory and policy topics that relate to cybersecurity, privacy and emerging technologies, and will provide (1) an overview of today's threat landscape, the legal frameworks governing data breaches, cybercrime and cyberwarfare; (2) an examination of data privacy laws and the issues surrounding governments' collection of personal data; and (3) an exploration of the impact emerging technologies have on regulatory agencies and public and private policies.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

CYBERSEC503 - Cybersecurity Risk Management

Course Description
Understanding and measuring risk is fundamental to protect an organization or enterprise from real and potential cybersecurity threats. Students will learn and apply various modeling techniques used to identify and quantify risk and explore how they are used to determine the value and criteria for managing risk. Risk management concepts and standards, including essential elements, effective governance, appetite for risk, and the need to develop appropriate policies and procedures to mitigate risk, will be explored across different industries and environments.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

CYBERSEC504 - Introductory Residency

Course Description
One-week course to introduce the Master of Engineering Cybersecurity Online Program. Residency 1 includes an orientation to Duke and the program, business simulations, case studies, professional development workshops and alumni engagement opportunities. Open only to students in the Master of Engineering Cybersecurity Online Program.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall Only

Units

Min Units:
0

Max Units:
0

CYBERSEC505 - Mid-Program Residency

Course Description
One-week course to assess interim progress for the Master of Engineering Cybersecurity Online Program. Residency 2 includes team-building exercises, case studies, leadership training, workshops, seminars and engagement opportunities. Prerequisite: CYBERSEC 504. Open only to students in the Master of Engineering Cybersecurity Online Program.

Grading Basis
Credit / No Credit

Course Typically Offered
Occasionally

Units

Min Units:
0

Max Units:
0

CYBERSEC510 - Security Incident Detection, Response, and Resilience

Course Description
Current and emerging technologies and processes to monitor, detect and respond to security incidents in systems, networks, and clouds will be covered including automation and analytics. Best practices for developing effective incident response plans, including regulatory and legal considerations, will be studied. Also studied is how to build resilience into development, manufacturing, or other business processes in the case of an incident.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

CYBERSEC520 - Applying Machine Learning to Advance Cybersecurity

Course Description
This course is designed to provide students hands on experience with machine learning, particularly in cybersecurity applications. This course will delve into the historical, current, and future applications of this technology in broad domains, including network defense and disinformation campaigns. Students will learn about state-of-the-art techniques being deployed today in security products, as well as burgeoning research areas for future growth. Students will also be exposed to the adversarial mindset and introduced to techniques seeking to disrupt defensive machine learning applications.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

CYBERSEC521 - Managing Cyber Threats through Effective Leadership Strategies

Course Description
To effectively prepare and respond to the ever-increasing and evolving cyberattacks, organizations must not only have a comprehensive plan but also execute that plan with great precision and consistency. Cybersecurity readiness is a critical and distinctive organizational competency, and this course is designed to enhance managerial awareness and capability to develop and sustain this competency.The course will provide a holistic and comprehensive insight into the different aspects of cybersecurity program management from development to administration, evaluation, and improvement of processes.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

CYBERSEC530 - Identity and Access Management

Course Description
This course will explore the everyday tasks and procedures that the IT security team employs to manage user and admin identities for authentication and access management. Students will learn the latest technologies and practices for multifactor authentication, single sign-on, and real-time privileges administration and what are the best practices for different use cases.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

CYBERSEC531 - The Human Element in Cybersecurity

Course Description
This course will examine the challenges associated with humans using, managing, and manipulating socio-technical systems with cybersecurity vulnerabilities. Technology and policy defenses and mitigations will be explored as well as societal, ethical, and legal implications of cybersecurity interventions.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

CYBERSEC535 - Secure Software Development

Course Description
This course is about minimizing risk when creating software and will focus on the fundamental structure of a Secure Development Life Cycle (SDLC), the advantages and challenges of cryptography, then explore automated testing solutions. Students will learn to effectively manage risk in the process of creating software. Hands-on experience with specific technologies prepare students to make informed decisions about the design, architecture, and implementation of software. Assignments use automated vulnerability hunting tools. Students will learn the risk profile of the target software project, and an understanding of how these tools add value to the overall secure development life cycle.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
FINTECH514 SECURE SOFTWARE DEVELOPMENT

CYBERSEC590 - Advanced Topics in Cybersecurity

Course Description
Opportunity for study of advanced subjects related to programs within cybersecurity tailored to fit the requirements of a small group. Permission of instructor required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

CYBERSEC591 - Special Readings in Cybersecurity

Course Description
Individual readings in advanced study and research areas of cybersecurity. Consent of instructor required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

DESIGNTK501S - Design and Technology Innovation Seminar

Course Description
Current topics in applied Design and Technology Innovation. Weekly seminar series.

Grading Basis
No Grade Associated

Course Typically Offered
Fall and/or Spring

Units

Min Units:
0

Max Units:
0

DESIGNTK520 - Design Innovation Studio 1

Course Description
In this course, students will practice applying design and innovation frameworks and methodologies in the context of a client-based project. As the first in the series of three courses core to the program, Design Innovation Studio I will focus on human-centered design, design thinking, and systems thinking as critical frameworks to frame problems and opportunities along with the client. Key outcomes from the class will include (1) opportunities identified and supported by qualitative and quantitative data; (2) concept directions that will support Design Innovation Studio II; and (3) a portfolio of early-stage prototypes and provocations used to guide data collection.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

DESIGNTK522 - Design Innovation Studio 3

Course Description
In this course, students will practice applying design and innovation frameworks and methodologies in the context of a near-semester-long project. As the third in a series of three courses core to the program, Design Innovation Studio III will focus on methodologies and frameworks to support implementation, assessment, iteration, narrative and storytelling, and organizational change. Key outcomes from the class will include (1) fluency in implementation, assessment, and iteration frameworks for deploying and sustaining design innovation; (2) compelling innovation narrative and storytelling skills to drive solution adoption and organizational change; (3) a portfolio-ready design innovation outcome.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

DESIGNTK530 - Design Technology Core 1

Course Description
In this course, students will advance their skills related to two technical toolkits core to design innovation practice: hardware prototyping, primarily digital fabrication and interactive systems developing using the Raspberry Pi single-board computing platform; and, introductory data science and machine learning, for driving data-driven design work in both hardware and digital applications. The course revolves around extensive in-class experimentation; weekly skill-building assignments; three mini-projects; and a final individual project intended to serve as a portfolio-ready piece.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

DESIGNTK540 - Design Ethics & Social Innovation

Course Description
In this course, students will briefly review foundational design and innovation frameworks, understanding their history and contemporary critiques of them. Design methodologies and frameworks related to design ethics, design justice, participatory and co-design, social innovation and adjacent themes will be introduced. The course will involve a semester-long innovation project leveraging frameworks from the class, focused on a single client.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

DESIGNTK590 - Advanced Topics in Design and Technology Innovation

Course Description
Opportunity for study of advanced subjects related to programs within Design and Technology Innovation tailored to fit the requirements of a small group.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

DESIGNTK590L - Advanced Topics in Design and Technology Innovation (with Lab)

Course Description
Opportunity for study of advanced subjects with laboratory related to programs within Design and Technology Innovation tailored to fit the requirements of a small group.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

DESIGNTK591 - Special Readings in Design and Technology Innovation

Course Description
Individual readings in advanced study and research areas of Design and Technology Innovation.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

ECE511 - Foundations of Nanoscale Science and Technology

Course Description
This course is the introductory course for the Graduate Certificate Program in Nanoscience (GPNANO) and is designed to introduce students to the interdisciplinary aspects of nanoscience by integrating important components of the broad research field together. This integrated approach will cross the traditional disciplines of biology, chemistry, electrical & computer engineering, computer science, and physics. Fundamental properties of materials at the nanoscale, synthesis of nanoparticles, characterization tools, and self-assembly. Prerequisites: Physics 152L and Chemistry 101DL or instructor approval.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
NANOSCI511 FOUNDATIONS NANOSCALE SCI/TECH, CHEM611 FOUNDATIONS NANOSCALE SCI/TECH

ECE512 - Emerging Nanoelectronic Devices

Course Description
Brief review of semiconductor device physics followed by coverage of the most prominent emerging nanoelectronic devices. Topics include: nanoelectronic logic devices (advanced silicon transistors, carbon nanotube transistors, spintronics, 2D FETs, NEMS, tunnel FETs, negative capacitance FETs and piezoelectronics), and nanoelectronic memory devices (phase change, spin transfer torque, nanomechanical, ferroelectric FET, and molecular memory). Students will understand basic operation, pros/cons of performance, and primary integration challenges. Students conduct case study project, culminating with class presentation. Prerequisite: ECE 230L or graduate student standing.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE516 - Thin-Film Photovoltaic Technology

Course Description
This course will focus in on a promising class of solar cells based on thin-film absorbers, some of which are already commercialized (e.g., CdTe, CIGS), while others are on the cutting edge of new photovoltaics technology (e.g., perovskites). The course will employ a combination of lecture, directed reading and hands-on approaches. The hands-on component of the course will involve fabricating PV devices and employing contemporary characterization and modeling tools to evaluate device performance. Specific techniques and the intellectual framework are more generally applicable to other PV and electronic devices. Recommended prerequisite: ECE 230 or related familiarity with electronic properties of materials. Open to graduate students; instructor consent required for undergraduate students to enroll.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ME516 THIN-FILM PV TECHNOLOGY

ECE520 - Graduate Introduction to Quantum Engineering

Course Description
Quantum mechanics was discovered at the beginning of the 20th century and has had a profound effect on the development of modern technology. This course is about the potential for quantum technologies in the 21st century. The focus of the course this semester will be a survey of quantum computation, a field that promises to revolutionize the way we compute by using the dynamics of quantum mechanics. Topics include quantum circuits, introduction to quantum algorithms, hardware, and architectures. Prerequisite: [ECE 270DL and ECE 280L and one of (Math 216, 218D-1, 218D-2, or 221)] or graduate standing. Not open to students who have taken ECE 420.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE521 - Quantum Mechanics

Course Description
Discussion of wave mechanics including elementary applications, free particle dynamics, Schrödinger equation including treatment of systems with exact solutions, and approximate methods for time-dependent quantum mechanical systems with emphasis on quantum phenomena underlying solid-state electronics and physics. Prerequisite: Mathematics 216 or equivalent.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ECE522 - Quantum Engineering with Atoms

Course Description
This course will cover basic sciences of atoms and their interaction with the electromagnetic field, basic atomic processes, and ways to engineer various sensors and quantum information processing systems utilizing basic atomic processes. Topics will include: Energy levels of hydrogen atom, fine-structure and hyperfine structure, atomic radiation, atomic coherence, atomic interaction with electromagnetic radiation, atomic sensors, atomic qubits, laser technology, optical control of atomic states.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE523 - Quantum Computing

Course Description
Fundamental concepts and progress in quantum information science. Quantum circuits, quantum universality theorem, quantum algorithms, quantum operations and quantum error correction codes, fault-tolerant architectures, security in quantum communications, quantum key distribution, physical systems for realizing quantum logic, quantum repeaters and long-distance quantum communication. Prerequisites: Electrical and Computer Engineering 521 or Physics 464 or equivalent.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
PHYSICS627 QUANTUM COMPUTING

General Education Curriculum Codes
(NS) Natural Sciences, (QS) Quantitative Studies

ECE524 - Introduction to Solid-State Physics

Course Description
Discussion of solid-state phenomena including crystalline structures, X-ray and particle diffraction in crystals, lattice dynamics, free electron theory of metals, energy bands, and superconductivity, with emphasis on understanding electrical and optical properties of solids. Prerequisite: quantum physics at the level of Physics 264L or Electrical and Computer Engineering 521.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

ECE526 - Semiconductor Devices for Integrated Circuits

Course Description
Semiconductor devices - pn junctions (including solar cells, light emitting diodes, photodetectors), metal-semiconductor junctions (as contacts and as Schottky diodes), MOS capacitors, MOSFETs (including short channel transistors), Bipolar Junction Transistors, heterojunctions. Prerequisite: Electrical and Computer Engineering 230L or a graduate student standing.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE528 - Nanoscale IC Chip Technology

Course Description
Key processing technologies for integrated circuits with an emphasis on the fundamentals of process scaling to fabricate nanoscale IC chips. Photolithographic scaling methods, modern photoresists, anti-reflection coatings, and optical and EUV exposure systems. Scaled pn junction formation with ion implantation and rapid thermal annealing, ultrathin gate dielectrics, silicon gate and metal gate technologies. Fundamentals of deposited metal and dielectric films driven by requirements for chip interconnections and wafer planarity. Prerequisite: ECE 230L and Chem 101DL, or graduate student standing.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ECE529 - Digital Integrated Circuits

Course Description
Analysis and design of digital integrated circuits in deep submicron MOS technology. Brief review of IC technology, MOSFETs, and interconnects. Switching characteristics (propagation delay) and power consumption in NMOS/CMOS devices and interconnects. Analysis of static and dynamic logic circuits (inverters, gates) and memory circuits (SRAMs, DRAMs, Flash). Influence of technology and device structure on performance and reliability of digital ICs. SPICE modeling. Memory array design project. Prerequisite: Electrical and Computer Engineering 331L or graduate student standing.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE531 - Power Electronic Circuits for Energy Conversion

Course Description
Efficient conversion of electrical energy is critical for electric and hybrid vehicles, wind and solar energy, power grids, computers, medical devices, and portables. This course teaches analysis and design of power electronic circuits for energy conversion, including circuit operation (converter topologies, steady-state modeling, switch realization), converter control (ac modeling, small-signal transfer functions, feedback), and magnetics (inductors, transformers). The course shares lectures with ECE/Energy Engineering 431, but has extended assignments. Prerequisite: ECE 230L or Engineering 224L or graduate student standing. Not open to students who have taken ECE 431 or Energy Engineering 431.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENRGYEGR531 PWR CKTS FOR ENERGY CONVERSION

ECE532 - Analog Integrated Circuit Design

Course Description
Design and layout of CMOS analog integrated circuits. Qualitative review of the theory of pn junctions, bipolar and MOS devices, large and small signal models. Emphasis on MOS technology. Continuous time op amps. Frequency response, stability, and compensation. Complex analog subsystems including phase-locked loops, A/D and D/A converters, switched capacitor simulation, layout, extraction, verification, MATLAB modeling. Projects make extensive use of full custom VLSI CAD software. Prerequisite: [(ECE 330L or 331L) & ECE 230L, 250D, 270DL & 280L and (Math 353 or 356) and (Math 230, 231, 340 or ECE 555 or STA 240L or EGR 238L) & Physics 152L & Chemistry 101DL] or a graduate student standing.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE533 - Biochip Engineering

Course Description
A problem-solving course in which students consider technology options for a complete lab-on-a-chip design. Lectures cover the basics of analog flow microfluidic devices, digital microfluidic devices, fabrication technologies for discrete devices, system integration issues, and a significant emphasis on biological applications for analysis, sample preparation, and detection issues. Technologies covered will include microfluidic devices, electrophoresis, analytical methods used in genetics, sample preparation methods, and analyte detection. Prerequisites: Biology 201L, Chem 101DL, and Physics 152L (or equivalents).

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE534 - Graduate Rainforest Engineering

Course Description
An open-format project-based class for graduate student team design with a focus on rainforests and related environments. Engages graduate students in cross-disciplinary team challenges that will teach them to work together with other students of differing backgrounds and skills. Design challenges are similar to the XPRIZE contests, or the NAE Grand Challenges. Graduate students taking this class will collaborate with undergraduates taking a similar class and are expected to provide mentorship and leadership for their undergraduate collaborators. Prerequisite: Graduate student standing.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENVIRON554 GRAD RAINFOREST ENGINEERING

ECE538 - VLSI System Testing

Course Description
Fault modeling, fault simulation, test generation algorithms, testability measures, design for testability, scan design, built-in self-test, system-on-a-chip testing, memory testing. Prerequisite: Electrical and Computer Engineering 350L or equivalent.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE539 - CMOS VLSI Design Methodologies

Course Description
Emphasis on full-custom digital ASIC design using CMOS technology. Extensive use of CAD tools for IC design, simulation, and layout verification. Includes techniques for designing high-speed, low-power, easily-testable circuits. Semester design project: Student groups design and simulate simple custom IC using Mentor Graphics CAD tools. Formal project proposal, written project report, and formal project presentation required. Prerequisite: [ECE 350L, 331L, 230L, 250D, 270DL, and 280L and (MATH 353 or 356) and (Statistical Science 240L or MATH 230 or MATH 231 or Mathematics 340 or ECE 555 or EGR 238L) and Physics 152L and Chemistry 101DL] or graduate-student standing.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE541 - Advanced Optics

Course Description
This course presents a rigorous treatment of topics in Photonics and Optics targeted at students with an existing photonics or optics background. Topics will include, Optical Sources, Statistical Optics and Coherence Theory, Detection of Radiation; Nonlinear Optics; Waveguides and Optical Fibers; Modern Optical Modulators; Ultrafast lasers and Applications. These topics will be considered individually and then from a system level perspective. Prerequisite: Electrical and Computer Engineering 340L or equivalent.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
BME552 ADVANCED OPTICS, PHYSICS621 ADVANCED OPTICS

ECE542 - Holography and Coherent Imaging

Course Description

Coherent imaging techniques generate images based on measurements of the amplitude/phase of the electromagnetic field rather than the time averaged energy flow (irradiance). In some frequency ranges, there exist technologies that allow for direct measurement of amplitude and phase, however, at higher frequencies only irradiance sensitive detectors exist. Here, coherent imaging requires the use of techniques like holography and interferometry that encode information about the amplitude/phase into the irradiance. This course examines coherent imaging in both these regimes and develops an understanding of the associated performance limits. Prerequisite: ECE 270DL or graduate student standing.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE543 - Statistical Optics

Course Description

Theoretical treatment of the statistical nature of optical fields via concepts such as second-order spatial and temporal coherence. Especially focuses on the theory of partial coherence and its applications including imaging with partially coherent light, laser speckle, and propagation through turbid/random media. Prerequisite: ECE 270DL or graduate student standing.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ECE544 - Nonlinear Optics

Course Description

This course is focused on fundamentals and applications of nonlinear light-matter interactions. The following topics will be considered: physical mechanisms of optical nonlinearity, nonlinear optical susceptibilities, intensity dependent refractive index, nonlinear wave mixing processes, optical self-action effects including self-focusing and optical solitons, optical phase conjugation, stimulated Brillouin and stimulated Raman scattering, supercontinuum generation, light filamentation, and nonlinear optical materials.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
PHYSICS544 NONLINEAR OPTICS

ECE545 - Foundations of Nanoelectronics & Nanophotonics

Course Description

Theory and applications of nanoelectronics and nanophotonics. Quantum dots and wells, metal nanoparticles, organic-inorganic interfaces, graphene, next generation transistors, light emitters, and sensors. Prerequisite: Electrical and Computer Engineering 230L and 270DL or equivalent.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE546 - Optoelectronic Devices

Course Description
Devices for conversion of electrons to photons and photons to electrons. Optical processes in semiconductors: absorption, spontaneous emission and stimulated emission. Light-emitting diodes (LEDs), semiconductor lasers, quantum-well emitters, photodetectors, modulators and optical fiber networks. Prerequisite: Electrical and Computer Engineering 526 or equivalent.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE549 - Optics and Photonics Seminar Series

Course Description
Weekly seminar on the current research topics in the field of optics and photonics.

Grading Basis
Credit / No Credit

Units

Min Units:
1

Max Units:
1

Crosslisted Courses
BME609 OPTICS & PHOTONICS SEMINAR SER, PHYSICS549 OPTICS & PHOTONICS SEMINAR SER

ECE550D - Fundamentals of Computer Systems and Engineering

Course Description
Fundamentals of computer systems and engineering for master's students whose undergraduate background did not cover this material. Topics covered include: Digital logic, assembly programming, computer architecture, memory hierarchies and technologies, IO, hardware implementation in VHDL, operating systems, and networking. Undergraduates may not take this course and should take ECE 250D, 353, and/or 356 instead. Co-requisite: ECE 551D. Not open to students who have taken or are taking ECE 552.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE550K - Fundamentals of Computer Systems and Engineering

Course Description
Fundamentals of computer systems and engineering for Master's students whose undergraduate background did not cover this material. Topics covered include: Digital logic, assembly programming, computer architecture, memory hierarchies and technologies, IO, hardware implementation in VHDL, operating systems, and networking. Taught at Duke Kunshan University in Kunshan, China. Corequisite: ECE 551DK.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE551D - Programming, Data Structures, and Algorithms in C++

Course Description
Students learn to program in C and C++ with coverage of data structures (linked lists, binary trees, hash tables, graphs), Abstract Data Types (Stacks, Queues, Maps, Sets), and algorithms (sorting, graph search, minimal spanning tree). Efficiency of these structures and algorithms is compared via Big-O analysis. Brief coverage of concurrent (multi-threaded) programming. Emphasis is placed on defensive coding, and use of standard UNIX development tools in preparation for students' entry into real world software development jobs. Not open to undergraduates.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE551K - Programming, Data Structures, and Algorithms in C++

Course Description
Students learn to program in C and C++ with coverage of data structures (linked lists, binary trees, hash tables, graphs), Abstract Data Types (Stacks, Queues, Maps, Sets), and algorithms (sorting, graph search, minimal spanning tree). Efficiency of these structures and algorithms is compared via Big-O analysis. Brief coverage of concurrent (multi-threaded) programming. Emphasis is placed on defensive coding, and use of standard UNIX development tools in preparation for students' entry into real world software development jobs. Taught at Duke Kunshan University in Kunshan, China.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE552 - Advanced Computer Architecture I

Course Description
Fundamental aspects of advanced computer architecture design and analysis. Topics include processor design, pipelining, superscalar, out-of-order execution, caches (memory hierarchies), virtual memory, storage systems, simulation techniques, technology trends and future challenges. Prerequisite: Computer Science 250 or Electrical and Computer Engineering 350 or equivalent.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI550 ADV COMPUTER ARCHITEC I

General Education Curriculum Codes
R - (R) Research, QC - (QC) Quant & Comp Reasoning: A&S Curriculum, QS - (QS) Quantitative Studies

ECE553 - Compiler Construction

Course Description

Covers the fundamentals of compiler design. Students will develop a working compiler, writing all stages required to take source code as input and produce working assembly as output: lexical analysis, parsing, type checking, translation to intermediate representation, instruction selection, liveness analysis, and register allocation. Students are expected to have a strong programming background prior to taking this course, as writing a compiler is a significant programming task. Prerequisites: Electrical and Computer Engineering 250L or Computer Science 250 or (ECE 550D and ECE 551D).

Grading Basis

Graded

Course Typically Offered

Spring Only

Units

Min Units:

3

Max Units:

3

Crosslisted Courses

COMPSCI553 COMPILER CONSTRUCTION

ECE554 - Fault-Tolerant and Testable Computer Systems

Course Description

Technological reasons for faults, fault models, information redundancy, spatial redundancy, backward and forward error recovery, fault-tolerant hardware and software, modeling and analysis, testing, and design for test. Prerequisite: Electrical and Computer Engineering 250D or equivalent.

Grading Basis

Graded

Course Typically Offered

Fall Only

Units

Min Units:

3

Max Units:

3

Crosslisted Courses

COMPSCI554 FAULT-TOLERANT/COMP SYS

ECE555 - Probability for Electrical and Computer Engineers

Course Description

Basic concepts and techniques used stochastic modeling of systems with applications to performance and reliability of computer and communications system. Elements of probability, random variables (discrete and continuous), expectation, conditional distributions, stochastic processes, discrete and continuous time Markov chains, introduction to queuing systems and networks. Prerequisite: Mathematics 216.

Grading Basis

Graded

Course Typically Offered

Fall Only

Units

Min Units:

3

Max Units:

3

Crosslisted Courses

COMPSCI555 PROBABILITY ELEC AND COMP EGRS

ECE556 - Wireless Networking and Mobile Computing

Course Description

Theory, design, and implementation of mobile wireless networking systems. Fundamentals of wireless networking and key research challenges. Students review pertinent journal papers. Significant, semester-long research project. Networking protocols (Physical and MAC, multi-hop routing, wireless TCP, applications), mobility management, security, and sensor networking. Prerequisites: Electrical and Computer Engineering 356 or Computer Science 310.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI515 WIRELESS NETWORKING

ECE557 - Computer Architecture and Hardware Acceleration

Course Description
This course is a graduate-level seminar in computer architecture with special topics in hardware acceleration. This course surveys the landscape of hardware acceleration from historical contexts to recent trends in system designs spanning a collection of architectural techniques (e.g., stream processing, dataflow architecture, parallelism applied to acceleration) and a variety of application domains (e.g. GPU, ML, Database, Graph, Genomics). This course also covers the taxonomy of accelerators, the hardware-software co-design of accelerators, and the deployment of accelerators using the AWS cloud. Prerequisite: Computer Architecture (COMPSCI 250D/ECE 250 or COMPSCI 550/ECE 552) and Digital Logic Design (COMPSCI 350/ECE 350 or ECE 550) or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI557 COMP ARCH & HW ACC

General Education Curriculum Codes
R - (R) Research, QS - (QS) Quantitative Studies

ECE558 - Advanced Computer Networks

Course Description
Entry-level graduate course. Basic systems support for process-to-process communications across a computer network. The TCP/IP protocol suite and the Berkeley sockets application programs interface. The topics include congestion control, packet scheduling, routing, software defined networking, datacenter networks, network function virtualization, programmable switches, network measurement, remote direct memory access, residential networks, peer-to-peer networks, and content distribution networks. Recommended prerequisite: entry-level computer systems course (Computer Science 310, 356, 510); knowledge of the C or Python.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI514 ADVANCED COMPUTER NETWORKS

General Education Curriculum Codes
R - (R) Research, QC - (QC) Quant & Comp Reasoning: A&S Curriculum, QS - (QS) Quantitative Studies

ECE559 - Advanced Digital System Design

Course Description
Fundamentals of an advanced digital system design, and the use of a hardware description language, VHDL, for their synthesis and simulation. System examples include the arithmetic/logic unit, memory, and microcontrollers. The team-based project incorporates engineering standards and realistic constraints and also considers Cost, environmental impact, manufacturability, health, and safety, ethics, social and political impact. Prerequisite: [ECE 350L, 230L, 250D, 270DL, and 280L and (MATH 353 or 356) and (STA 240L or MATH 230 or MATH 231 or MATH 340 or ECE 380 or ECE 555 or EGR 238L) & PHYS 152L & CHEM 101DL and ECE 331L (prerequisite or corequisite)] or a graduate student standing.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ECE560 - Computer and Information Security

Course Description
An intense trip through many facets of computer and information security. Includes discussion and practical exercises in risk management, threat modeling, applied cryptography, malicious software, network security, intrusion detection and prevention, software and OS security, auditing and forensics, reverse engineering, and social engineering. Includes many hands-on security assignments. Prerequisite: Computer Science 310, ECE 353, or ECE 650.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE561 - Datacenter Architecture

Course Description
Ethical inquiry into journalism and its effect on public discourse. Issues include accuracy, transparency, conflicts of interest and fairness. Topics include coverage of national security, government secrecy, plagiarism/fabrication, and trade-offs of anonymous sourcing.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

ECE563 - Cloud Computing

Course Description
In a seminar format, explore a number of the underlying technologies, business models, and innovations underpinning current widespread deployment of 'cloud' computing systems, services, and applications. Each student will be expected to choose a relevant subject, identify appropriate advance readings for the class, and lead one discussion on topics of interest to the group. There will be a project component to the course; some projects may be in the form of literature reviews and papers, others will involve practical experience creating and deploying a useful service or application in a cloud environment.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE564 - Mobile Application Development

Course Description

Explores mobile application development in the Apple Development Environment. Uses core software engineering pillars of Swift, Xcode, iOS & Xcode Cloud to learn how to create apps for Apple products. Focuses on iOS/iPhone, but Xcode also allows for exploration into the VisionPro, the Apple Watch, the iPad, and Apple TV. Real world context focused on common programming patterns for engineers in academia or business - standalone apps, apps connected to other systems, apps connected to the cloud. Covers software engineering fundamentals essential to understanding all aspects of app development. Each team will deliver a fully functioning app. Recommended prerequisite: CompSci 307D or CompSci 308 or ECE 651.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

ECE565 - Performance Optimization & Parallelism

Course Description

Analyzing and optimizing the performance of software, in both a single- and multi-threaded setting. Apply knowledge of hardware, programming, and assembly to both tasks. Single-threaded performance topics include code profiling & analysis, loop transformation, analysis of interaction of code & memory hierarchy, assembly level instruction scheduling impacts. Multi-threaded topics include scalability & load balance. For students with strong foundation of programming skills in high-level languages, assembly language, and computer architecture & design. Prerequisite: [(ECE/CompSci 250D and [CompSci 310 or ECE 353]) or (ECE 550D and (ECE 551D or ECE 751D))] and ECE 552 (may be taken concurrently).

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE566 - Enterprise Storage Architecture

Course Description

Study the design and deployment of massive storage systems of the sort used in large enterprises (banks, major IT departments, service providers, etc.). Includes coverage of hard disk and flash design, RAID, SAN and NAS topologies, filesystem design, data center architectures for high availability, data deduplication, business continuity, and the economics of data storage with respect to cloud computing. Includes a few homeworks and a semester-long programming project. Prerequisite: graduate students: ECE 650; undergraduate students: Computer Science 310 or ECE 353.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE567 - Cyber-Physical System Design

Course Description

Complex interactions between information technology and physical world in Cyber-Physical Systems (CPS) challenge standard design methods that ignore cross-cutting constraints. This course addresses CPS design challenges by exploiting theory and methods from embedded systems, controls, and formal methods. Course covers topics related to the integration of system modeling, analysis, and automatic synthesis into design frameworks that ensure closed-loop safety and performance under known and unknown operating conditions. Balances establishing a working knowledge of CPS design and analysis methods with understanding the theory behind them. Prerequisite: ECE 350L and Computer Science 310/ECE 353, or graduate-student standing.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

ECE568 - Engineering Robust Server Software

Course Description
In this course, students learn about important principles in server software design and development. These principles include topics such as handling asynchronous behavior, design for failure, basic security principles, scalability, and resilience. Students will put these ideas into practices by developing software reflecting the ideas learned in class. Prerequisite: (ECE 551D or ECE 751D) and corequisite ECE 650, or [(Computer Science 307D or Computer Science 308) and (ECE 353 or CompSci 310) and (ECE 356 or CompSci 356)].

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE571 - Electromagnetic Theory

Course Description
The classical theory of Maxwell's equations; electrostatics, magnetostatics, boundary value problems including numerical solutions, currents and their interactions, and force and energy relations. Three class sessions. Prerequisite: Electrical and Computer Engineering 270DL.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE572 - Electromagnetic Communication Systems

Course Description
Review of fundamental laws of Maxwell, Gauss, Ampere, and Faraday. Elements of waveguide propagation and antenna radiation. Analysis of antenna arrays by images. Determination of gain, loss, and noise temperature parameters for terrestrial and satellite electromagnetic communication systems. Prerequisite: Electrical and Computer Engineering 270DL or 571.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE573 - Optical Communication Systems

Course Description
Mathematical methods, physical ideas, and device concepts of optoelectronics. Maxwell's equations, and definitions of energy density and power flow. Transmission and reflection of plane waves at interfaces. Optical resonators, waveguides, fibers, and detectors are also presented. Prerequisite: Electrical and Computer Engineering 270DL or equivalent.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ECE574 - Waves in Matter

Course Description
Analysis of wave phenomena that occur in materials based on fundamental formulations for electromagnetic and elastic waves. Examples from these and other classes of waves are used to demonstrate general wave phenomena such as dispersion, anisotropy, and causality; phase, group, and energy propagation velocities and directions; propagation and excitation of surface waves; propagation in inhomogeneous media; and nonlinearity and instability. Applications that exploit these wave phenomena in general sensing applications are explored. Prerequisite: Electrical and Computer Engineering 270DL.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ECE575 - Microwave Electronic Circuits

Course Description
Microwave circuit analysis and design techniques. Properties of planar transmission lines for integrated circuits. Matrix and computer-aided methods for analysis and design of circuit components. Analysis and design of input, output, and interstage networks for microwave transistor amplifiers and oscillators. Topics on stability, noise, and signal distortion. Prerequisite: Electrical and Computer Engineering 270DL or equivalent.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE577 - Computational Electromagnetics

Course Description
Systematic discussion of useful numerical methods in computational electromagnetics including integral equation techniques and differential equation techniques, both in the frequency and time domains. Hands-on experience with numerical techniques, including the method of moments, finite element and finite-difference time-domain methods, and modern high order and spectral domain methods. Prerequisite: Electrical and Computer Engineering 571 or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE580 - Introduction to Machine Learning

Course Description
Introduction to core concepts in machine learning and statistical pattern recognition, with a focus on discriminative and generative classifiers (nearest-neighbors, Bayes, logistic regression, linear discriminant, support vector machine, and relevance vector machine). Dimensionality reduction and feature selection. Classifier performance evaluation, bias-variance tradeoff, and cross-validation. Prerequisite: (Mathematics 216, 218D-1, 218D-2, or 221, or ECE 586) and (Computer Science 201 or ECE 551D) and (ECE 480 or ECE 581 or MATH 541 or MATH 730 or MATH 740). Not open to students who have taken Computer Science 671D.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE580K - Introduction to Machine Learning

Course Description
Introduction to core concepts in machine learning and statistical pattern recognition, with a focus on discriminative and generative classifiers (nearest-neighbors, Bayes, logistic regression, linear discriminant, support vector machine, and relevance vector machine). Dimensionality reduction and feature selection. Classifier performance evaluation, bias-variance tradeoff, and cross-validation. Taught at Duke Kunshan University in Kunshan, China.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ECE581 - Random Signals and Noise

Course Description
Introduction to mathematical methods of describing and analyzing random signals and noise. Review of basic probability theory; joint, conditional, and marginal distributions; random processes. Time and ensemble averages, correlation, and power spectra. Optimum linear smoothing and predicting filters. Introduction to optimum signal detection, parameter estimation, and statistical signal processing. Prerequisite: one of (STA 130L or STA 240L or Mathematics 230 or or Mathematics 340 or ECE 380 or ECE 555 or EGR 238L) or graduate student standing.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE581K - Random Signals and Noise

Course Description
Introduction to mathematical methods of describing and analyzing random signals and noise. Review of basic probability theory; joint, conditional, and marginal distributions; random processes. Time and ensemble averages, correlation, and power spectra. Optimum linear smoothing and predicting filters. Introduction to optimum signal detection, parameter estimation, and statistical signal processing. Taught at Duke Kunshan University in Kunshan, China.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE582 - Digital Signal Processing

Course Description

Introduction to fundamental algorithms used to process digital signals. Basic discrete time system theory, the discrete Fourier transform, the FFT algorithm, linear filtering using the FFT, linear production and the Wierner filter, adaptive filters and applications, the LMS algorithm and its convergence, recursive least-squares filters, nonparametric and parametric power spectrum estimation minimum variance and eigenanalysis algorithms for spectrum estimation. Prerequisite: Electrical and Computer Engineering 581 or equivalent with consent of the instructor.

Grading Basis

Graded

Course Typically Offered

Spring Only

Units

Min Units:

3

Max Units:

3

ECE583 - Data Science

Course Description

Data science is 'the science of planning for, acquisition, management, analysis of, and inference from data'. This course systematically covers the concepts, ideas, tools, and example applications of data science in an end-to-end manner. We emphasize data-driven thinking, data processing and analytics, and extracting actionable values from data. We focus on the interactions between data and applications, data modeling, and data processing, data analytics, and the essential algorithms and tools. Prerequisites: A statistics course (Statistics 111 or higher), data structures and algorithms (Computer Science 201), and relational databases (Computer Science216 or 316).

Grading Basis

Graded

Course Typically Offered

Fall Only

Units

Min Units:

3

Max Units:

3

Crosslisted Courses

COMPSCI526 DATA SCIENCE, CBB526 DATA SCIENCE

General Education Curriculum Codes

QC - (QC) Quant & Comp Reasoning: A&S Curriculum, QS - (QS) Quantitative Studies

ECE585 - Signal Detection and Extraction Theory

Course Description

Introduction to signal detection and information extraction theory from a statistical decision theory viewpoint. Subject areas covered within the context of a digital environment are decision theory, detection and estimation of known and random signals in noise, estimation of parameters and adaptive recursive digital filtering, and decision processes with finite memory. Applications to problems in communication theory. Prerequisite: Electrical and Computer Engineering 581 or consent of instructor.

Grading Basis

Graded

Course Typically Offered

Spring Only

Units

Min Units:

3

Max Units:

3

ECE586D - Vector Space Methods with Applications

Course Description
Key concepts from advanced linear algebra that are used regularly in ECE/CS journal papers on signal processing, communications, circuit design, and machine learning (e.g., logic, topology, vector spaces, optimization). Key mathematical ideas/proofs will be presented and applied. Uses application topics such as Markov chains, alternating projections, pattern classification to illustrate important mathematical topics. Background in linear algebra, a high-level programming language, and probability is assumed. Prerequisites: [(Math 216, 221, or 218-2) & (EGR 103L or CS 201) & (STA 130 or STA 240L or Math 230 or Math 340 or ECE 380 or ECE 555 or EGR 238L) & ECE 280L] or graduate student standing.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE586K - Vector Space Methods with Applications

Course Description
Covers key concepts from advanced linear algebra that are used regularly in ECE/CS journal papers on signal processing, communications, circuit design, and machine learning (e.g., logic, topology, vector spaces, optimization). For each topic, key mathematical ideas/proofs will be presented and applied. The goal is to use application topics such as Markov chains, alternating projections, and pattern classification to illustrate important mathematical topics. Background in linear algebra, a high-level programming language, and probability is assumed. Taught at Duke Kunshan University in Kunshan, China.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE587 - Information Theory

Course Description
Information theory is the science of processing, transmitting, storing, and using information. This course provides an introduction to mathematical measures of information and their connection to practical problems in communication, compression, and inference. Entropy, mutual information, lossless data compression, channel capacity, Gaussian channels, rate distortion theory, Fisher information. Useful for researchers in a variety of fields, including signal processing, machine learning, statistics, and neuroscience. Appropriate for beginning graduate students in electrical engineering, computer science, statistics, and math with a background in probability.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
STA563 INFORMATION THEORY

ECE588 - Image and Video Processing: From Mars to Hollywood with a Stop at the Hospital

Course Description
Intro to image formation, image compression, image enhancement & image segmentation. Covers geometric and non-geometric tools, as well as spatial and non-spatial operations. Extension to color images and video. Addresses recent progress in the area, including image inpainting (how to remove objects from images and video), image processing via sparse modeling & compressed sensing, geometric partial differential equations for image analysis, image processing for HIV & virus research, image processing for neurosurgery & other medical applications. Prerequisite: [ECE 280L and (Mathematics 216, 218D-1, 218D-2, or 221) and (STA 130L or STA 240L or Mathematics 230 or Mathematics 340 or ECE 380 or ECE 555 or EGR 238L)] or graduate student standing.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE590 - Advanced Topics in Electrical and Computer Engineering

Course Description
Opportunity for study of advanced subjects related to programs within the electrical and computer engineering department tailored to fit the requirements of a small group. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

ECE590A - Advanced Topics in Electrical and Computer Engineering

Course Description
Opportunity for study of advanced subjects related to programs within the electrical and computer engineering department tailored to fit the requirements of a small group. Instructor consent required. Taught in Beaufort at Duke Marine Lab.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

ECE590D - Advanced Topics in Electrical and Computer Engineering

Course Description
Opportunity for study of advanced subjects related to programs within the electrical and computer engineering department tailored to fit the requirements of a small group. Has discussion.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

ECE590K - Advanced Topics in Electrical and Computer Engineering

Course Description
Opportunity for study of advanced subjects related to programs within the electrical and computer engineering department tailored to fit the requirements of a small group. Taught at Duke Kunshan University in Kunshan, China.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

ECE621 - Quantum Error Correction

Course Description
In this course, we cover two related topics: quantum error correction and quantum computer architectures. In the beginning of the course, we will cover the basics of quantum error correction and develop the tools needed to understand modern methods of fault-tolerant quantum computation. In the end of the course, we will discuss how quantum error correction influences the design of a large-scale quantum computer. Prerequisite: ECE 523/PHYSICS 627 or ECE 420 or ECE 520.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
PHYSICS628 QUANTUM ERROR CORRECTION

ECE623 - Quantum Information Theory

Course Description
Introduction to fundamental ideas of Quantum Information theory, such as entanglement, quantum entropy, mutual information, and data compression. A primary goal of this field is to understand how quantum effects, such as entanglement, can enhance communication protocols. These concepts are also essential for quantifying noise and decoherence in quantum computers. Furthermore, they have various applications in other areas, including quantum thermodynamics and many-body physics. Prerequisite: [ECE 420 or ECE 520 or ECE 521 or PHYSICS 464] and [ECE 586 or MATH 216 or MATH 218D-1 or MATH 218D-2 or MATH 221].

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
PHYSICS623 QUANTUM INFORMATION THEORY

ECE624 - Open Quantum Systems

Course Description
Experimental quantum systems are inevitably coupled to their environment. This leads to dissipation and decoherence, which pose challenges for quantum technology but can also be used to drive novel effects. Open quantum systems are described using density operators, quantum channels, and second quantization. We will derive the Lindblad master equation which can explain dissipation, decoherence, and thermalization. Experimental platforms for quantum computation and simulation will be discussed from this viewpoint. Advanced concepts covered may include nonequilibrium phase transitions, quantum trajectories, tensor networks, and the Keldysh formalism. Recommended prerequisite: PHYSICS 464 or ECE 521

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
PHYSICS624 OPEN QUANTUM SYSTEMS

General Education Curriculum Codes
NS - (NS) Natural Sciences, QS - (QS) Quantitative Studies

ECE631 - Analog and RF Integrated Circuit Design, Fabrication, and Test

Course Description
For students who have some experience in analog circuit design and want to fabricate and test an IC under faculty supervision. Typically taken over three semesters (Fall, Spring, Summer, or Fall, Spring, Fall) to accommodate design-fabricate-test cycle. Design cycle: students use Cadence or Mentor IC layout tools, and HSPICE or ADS simulation tools. Fabrication cycle: a detailed test plan is developed. Test cycle: students access test facility appropriate for design and submit a report to the IC fabrication foundry. Co-requisite: ECE 539, or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
2

ECE650 - Systems Programming and Engineering

Course Description
Focuses on a range of topics that are central to both the design of operating systems and the programming system-level software. Students will apply knowledge of basic concepts in operating systems, networking, and programming towards these two areas. Topics covered will include concurrency, process management, hypervisors, networking, security, databases, and file systems. Students will be expected to demonstrate their understanding in these areas through a series of programming assignments covering these topics. Prerequisite: ECE 550D and (ECE 551D or ECE 751D).

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE650K - Systems Programming and Engineering

Course Description
Focuses on a range of topics that are central to both the design of operating systems and the programming system-level software. Students will apply knowledge of basic concepts in operating systems, networking, and programming towards these two areas. Topics covered will include concurrency, process management, hypervisors, networking, security, databases, and file systems. Students will be expected to demonstrate their understanding in these areas through a series of programming assignments covering these topics. Taught at Duke Kunshan University in Kunshan, China. Prerequisite: ECE 550K and ECE 551K.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE651 - Software Engineering

Course Description
Teaches students about all steps of the software development lifecycle: requirements definition, design, development, testing, and maintenance. The course assumes students are skilled object-oriented programmers from prior courses, but will include a rapid introduction to Java. Students complete team-based semester-long software project which will progress through all phases of the software lifecycle. Prerequisite: Electrical and Computer Engineering 551D or 751D.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE651K - Software Engineering

Course Description
Teaches students about all steps of the software development lifecycle: requirements definition, design, development, testing, and maintenance. The course assumes students are skilled object-oriented programmers from prior courses, but will include a rapid introduction to Java. Students complete team-based semester-long software project which will progress through all phases of the software lifecycle. Taught at Duke Kunshan University in Kunshan, China. Prerequisite: ECE 551K.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE652 - Advanced Computer Architecture II

Course Description
Parallel computer architecture design and evaluation. Design topics include parallel programming, message passing, shared memory, cache coherence, cache coherence, memory consistency models, symmetric multiprocessors, distributed shared memory, interconnection networks, and synchronization. Evaluation topics include modeling, simulation, and benchmarking. Prerequisite: Computer Science 550 or Electrical and Computer Engineering 552 or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI650 ADV COMPUTER ARCHITEC II

General Education Curriculum Codes
QC - (QC) Quant & Comp Reasoning: A&S Curriculum, QS - (QS) Quantitative Studies

ECE653 - Human-Centered Computing

Course Description
This course addresses the importance of the human-computer interface in the design and development of things that people use. Many of the perceptual, cognitive, and social characteristics of people, as well as methods for learning more about the people, are covered. The capabilities and limits of computers and other related systems are discussed as they relate to the impact on design and implementation decisions. The course consists of a semester-long project that steps through the various stages of design. This semester's project will be reimaging on campus mental health management. Prerequisite: Computer Science 307D or 308 or Electrical and Computer Engineering 651.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI653 HUMAN-CENTERED COMPUTING

ECE654 - Edge Computing

Course Description
A seminar-format examination of design principles and recent advances in edge computing, a distributed networked system architecture that places computing and storage at multiple locations between the user and the cloud. The class covers edge computing platforms, edge-adapted algorithms, and the use of edge in mobile and Internet of Things systems and applications. The class focuses on in-depth examinations of key scientific advances in the field. Students complete and present a research-based project, individual or team-based. Prerequisite: ECE/COMPSCI 356 or ECE/COMPSCI 350L or ECE 353/COMPSCI 310 or Graduate Standing.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI564 EDGE COMPUTING

ECE655L - Full-Stack IoT Systems

Course Description
This course focuses on the principles and applications of full-stack Internet-of-Things (IoT). It covers the hardware and software components of building cyber-physical systems (CPS) for IoT applications, including embedded platforms with various sensors and actuators, wireless and wired networks, cloud service, and platforms, data visualization and analytics, and end-to-end IoT applications. This course includes lab sessions and group projects, where students create and build working CPS/IoT systems. Prerequisite: Computer Science 210D, Computer Science 250D, Electrical & Computer Engineering 250D, or Electrical & Computer Engineering 550D.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI655L FULL-STACK IOT SYSTEMS

ECE656 - Cryptography

Course Description
Introduction to the design and analysis of cryptographic algorithms. Topics include basics of abstract algebra and number theory; symmetric and asymmetric encryption algorithms; cryptographic hash functions; message authentication codes; digital signature schemes; elliptic curve algorithms; side-channel attacks; and selected advanced topics. Prerequisite: COMPSCI 230 or equivalent or graduate standing.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI582 CRYPTOGRAPHY

General Education Curriculum Codes
QC - (QC) Quant & Comp Reasoning: A&S Curriculum, QS - (QS) Quantitative Studies

ECE657 - Human-Centered Security and Privacy

Course Description
This course will introduce several security and privacy topics that have strong human factors component. Some of the themes that we cover throughout this course include overview of User Research Methods and Ethics, Equity and Inclusivity in Security and Privacy, Challenges In Designing Usable Security and Privacy Tools, Security and Privacy Education and Awareness, and Human-Centered Security and Privacy in Emerging Technologies. This course includes weekly reading commentaries, a midterm exam, and a final group research project. Recommended prerequisite: user research methods and CompSci 201 or equivalent programming experience.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI586 USABLE SECURITY AND PRIVACY, PUBPOL586 USABLE SECURITY AND PRIVACY, ISS586 USABLE SECURITY AND PRIVACY

ECE661 - Computer Engineering Machine Learning and Deep Neural Nets

Course Description
This course examines various computer engineering methods commonly performed in developing machine learning and deep neural network models. The focus of the course is on how to improve the training and inference performance in terms of model accuracy, size, runtime, etc. Techniques that are widely investigated and adopted in industrial companies and academic communities will be discussed and practiced. Programming practices on these techniques are designed with heavy utilization of the PyTorch package. Prerequisites: Computer Science 201 or ECE 551D or ECE 751D.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE662 - Machine Learning Acceleration and Neuromorphic Computing

Course Description
The rapidly growing size of neural networks adopted in modern artificial intelligence (AI) applications makes accelerating computations of machine learning algorithms a critical need of the industry. This course will introduce various approaches to design high-efficient neural network models and to include hardware constraints in the efficient neural network designs. We will also discuss the hardware techniques that can accelerate the computations of neural networks on different computing platforms such as GPU, FPGA, and ASIC. Bio-inspired computing and neuromorphic computing will be also discussed. The course is a mix of lectures, labs, & projects. Prerequisite: ECE 250D/COMPSCI 250D, or ECE 552/COMPSCI 550, or permission of instructor.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE663 - Machine Learning in Adversarial Settings

Course Description
Machine learning is being widely deployed in many aspects of our society. Our vision is that machine learning systems will become a new attack surface and attackers will exploit the vulnerabilities in machine learning algorithms and systems to subvert their security and privacy. In this course, we will discuss security and privacy attacks to machine learning systems and state-of-the-art defenses against them. Prerequisite: ECE 580 or 687D or Computer Science 371 or graduate standing

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE675 - Optical Imaging and Spectroscopy

Course Description
Wave and coherence models for propagation and optical system analysis. Fourier optics and sampling theory. Focal plane arrays. Generalized and compressive sampling. Impulse response, modulation transfer function and instrument function analysis of imaging and spectroscopy. Code design for optical measurement. Dispersive and interferometric spectroscopy and spectral imaging. Performance metrics in optical imaging systems. Prerequisite: Electrical and Computer Engineering 270DL and 280L.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

ECE681 - Pattern Classification and Recognition Technology

Course Description
Theory and practice of recognition technology: pattern classification, pattern recognition, automatic computer decision-making algorithms. Applications covered include medical diseases, severe weather, industrial parts, biometrics, bioinformation, animal behavior patterns, image processing, and human visual systems. Perception as an integral component of intelligent systems. This course prepares students for advanced study of data fusion, data mining, knowledge base construction, problem-solving methodologies of 'intelligent agents' and the design of intelligent control systems. Prerequisites: Mathematics 216, Statistical Science 130 or Mathematics 230, Computer Science 101, or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ECE682D - Probabilistic Machine Learning

Course Description
Introduction to concepts in probabilistic machine learning with a focus on discriminative and hierarchical generative models. Topics include directed and undirected graphical models, kernel methods, exact and approximate parameter estimation methods, and structure learning. Prerequisite: Linear algebra, Statistical Science 250 or Statistical Science 611.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
STA561D PROBABILISTIC MACHINE LEARNING, COMPSCI571D PROBABILISTIC MACHINE LEARNING

General Education Curriculum Codes
QC - (QC) Quant & Comp Reasoning: A&S Curriculum, QS - (QS) Quantitative Studies

ECE683 - Digital Communication Systems

Course Description
Digital modulation techniques. Coding theory. Transmission over bandwidth constrained channels. Signal fading and multipath effects. Spread spectrum. Optical transmission techniques. Prerequisite: Electrical and Computer Engineering 581 or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ECE684 - Natural Language Processing

Course Description
Introduction to algorithmic and analytic methods specific to textual data. Subject areas covered are speech recognition, optical character recognition, text parsing, and document analysis. Analysis tools taught include sentiment analysis/topic models, auto-correct, auto-complete, and translation systems. Applications to brain-computer interface communication systems, intelligent personal assistants, and plagiarism detection systems. Prerequisite: ECE 480 or ECE 580 or ECE 581 or ECE 682D or Mathematics 541 or Mathematics 730 or Mathematics 740.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ECE685D - Introduction to Deep Learning

Course Description
Provides an introduction to the machine learning technique called deep learning or deep neural networks. A focus will be the mathematical formulations of deep networks and an explanation of how these networks can be structured and 'learned' from big data. Discussion section covers practical applications, programming, and modern implementation practices. Example code and assignments will be given in Python with heavy utilization of PyTorch (or Tensorflow) package. The course and a project will cover various applications including image classification, text analysis, object detection, etc. Prerequisite: ECE 580, ECE 681, ECE 682D, Statistical Science 561D, or Computer Science 571D.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI675D INTRO TO DEEP LEARNING

ECE685K - Introduction to Deep Learning

Course Description
Provides an introduction to the machine learning technique called deep learning or deep neural networks. A focus will be the mathematical formulations of deep networks and an explanation of how these networks can be structured and 'learned' from big data. Discussion section covers practical applications, programming, and modern implementation practices. Example code and assignments will be given in Python with heavy utilization of PyTorch (or Tensorflow) package. The course and a project will cover various applications including image classification, text analysis, object detection, etc. Prerequisite: ECE 580K.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ECE686 - Adaptive Filters

Course Description
Adaptive digital signal processing with emphasis on the theory and design of finite-impulse response adaptive filters. Stationary discrete-time stochastic processes, Wiener filter theory, the method of steepest descent, adaptive transverse filters using gradient-vector estimation, analysis of the LMS algorithm, least-squares methods, recursive least squares and least squares lattice adaptive filters. Application examples in noise canceling, channel equalization, and array processing. Prerequisites: Electrical and Computer Engineering 581 and 582 or consent of instructor.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

ECE687D - Theory and Algorithms for Machine Learning

Course Description
This is an introductory overview course at an advanced level. Covers standard techniques, such as the perceptron algorithm, decision trees, random forests, boosting, support vector machines and reproducing kernel Hilbert spaces, regression, K-means, Gaussian mixture models and EM, neural networks, and multi-armed bandits. Covers introductory statistical learning theory. Recommended prerequisite: linear algebra, probability, analysis or equivalent.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI671D THEORY & ALG MACHINE LEARNING, STA671D THEORY & ALG MACHINE LEARNING

General Education Curriculum Codes
QC - (QC) Quant & Comp Reasoning: A&S Curriculum, QS - (QS) Quantitative Studies

ECE688 - Sensor Array Signal Processing

Course Description
An in-depth treatment of the fundamental concepts, theory, and practice of sensor array processing of signals carried by propagating waves. Topics include: multidimensional frequency-domain representations of space-time signals and linear systems; apertures and sampling of space-time signals; beamforming and filtering in the space-time and frequency domains, discrete random fields; adaptive beamforming methods; high resolution spatial spectral estimation; optimal detection, estimation, and performance bounds for sensor arrays; wave propagation models used in sensor array processing; blind beamforming and source separation methods; multiple-input-multiple-output (MIMO) array processing; application examples from radar, sonar, and communications systems.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ECE689 - Advanced Topics in Deep Learning

Course Description
Focus on advanced topics in deep learning, particularly methodological methods. This includes discriminative models (e.g., infinite/infinitesimal/physics-informed neural networks), generative models (normalizing flows, graphical models, Bayesian Neural Networks, non-parametric approaches), and topics on inference (e.g., exact and approximate inference methods). Assignments will provide an opportunity to implement techniques. Prerequisite: ECE 685D.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI676 ADV TOPICS IN DEEP LEARNING

ECE701K - Being a Successful ECE Masters Student

Course Description
This seminar helps first year Masters students prepare for success in both their academics and longer term careers. Events/topics include community building, discussions of effective learning strategies, industry panels on career options, professional networking, academic integrity, and the breadth of resources available for students to deal with difficulties. Taught at Duke Kunshan University in Kunshan, China.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall Only

Units

Min Units:
0

Max Units:
0

ECE701S - Being a Successful ECE Masters Student

Course Description
This seminar helps first-year Masters students prepare for success in both their academics and longer-term careers. Events/topics include community building, discussions of effective learning strategies, industry panels on career options, professional networking, academic integrity, and the breadth of resources available for students to deal with difficulties.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall Only

Units

Min Units:
0

Max Units:
0

ECE721 - Nanotechnology Materials Lab

Course Description
This course provides an introduction to advanced methods for the characterization and fabrication of materials, nanostructures, and devices. Cleanroom methods to be covered include lithography, evaporation, and etching. Characterization methods include electron microscopy, atomic force microscopy, X-ray photoelectron spectroscopy, and optical spectroscopy. Students will receive an overview of the techniques in the Shared Materials Instrumentation Facility through lectures and demonstrations. In the lab section, each student will engage in a project that focuses on those capabilities that are needed for their research, and will receive training and certification on that equipment.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ME711 NANOTECHNOLOGY MATERIALS LAB

ECE722 - Quantum Electronics

Course Description
Quantum theory of light-matter interaction. Laser physics (electron oscillator model, rate equations, gain, lasing condition, oscillation dynamics, modulation) and nonlinear optics (electro-optic effect, second harmonic generation, phase matching, optical parametric oscillation and amplification, third-order nonlinearity, optical bistability.) Prerequisite Electrical and Computer Engineering 521, Physics 464, or equivalent.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

ECE741 - Compressed Sensing and Related Topics

Course Description
Introduction to the basic compressed sensing problems and methodologies, including the recovery of sparse vectors and low-rank matrices using methods based on convex optimization and approximate message passing. Unified theoretical framework for the analysis of certain CS problems, drawing upon ideas from statistical decision theory, high-dimensional convex geometry, information theory, convex optimization, message passing and variational inference with graphical models, and the replica method from statistical physics.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
STA741 COMPRESSED SENSING

ECE751D - Advanced Programming, Data Structures, and Algorithms in C++

Course Description

Students learn C++, data structures (linked lists, balanced BSTs, hash tables, graphs), Abstract Data Types (Stacks, Queues, Maps, Sets), & algorithms (sorting, graph search, minimal spanning tree). Efficiency of such structures & algorithms compared via Big-O analysis. Students learn multi-threaded programming. Emphasis on defensive coding, and use of standard UNIX development tools in preparation for students' entry into real world software development jobs. Strong C programming skills required to enroll. Those without such skills should take Electrical and Computer Engineering 551D instead. Instructor consent required. Not open to students who have taken or are currently taking Electrical and Computer Engineering 551D.

Grading Basis

Graded

Course Typically Offered

Fall Only

Units

Min Units:

3

Max Units:

3

ECE781 - Advanced Topics in Signal Processing

Grading Basis

Graded

Units

Min Units:

3

Max Units:

3

ECE784LA - Sound in the Sea: Introduction to Marine Bioacoustics

Course Description

Fundamentals marine bioacoustics with focus on current literature and conservation issues. Topics include: intro acoustics; acoustic analysis methods and quantitative tools; production/recording of sound; ocean noise; propagation theory; active/passive acoustics; hearing, sound production and communication in marine organisms, potential impacts of anthropogenic noise; and regulation of marine sound. Lab focus on methodologies for generating, recording and analyzing marine sounds. Grad students responsible for additional acoustic analyses and results prep for student projects plus preparation additional lit review/critique. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP or introductory biology or consent; Physics 41L or 161L (or equivalent) or consent.

Grading Basis

Graded

Units

Min Units:

4

Max Units:

4

Crosslisted Courses

BIOLOGY784LA MARINE BIOACOUSTICS, ENVIRON784LA MARINE BIOACOUSTICS

ECE891 - Internship

Course Description

Student gains practical electrical and computer engineering experience by taking a job in industry and writing a report about this experience. May be repeated with consent of the advisor and the director of graduate studies. A full-time internship is available to ECE graduate students if it allows them to gain practical experience in a work environment related to their academic training and enhances their overall academic experience and, for students on F-1 Visa, their employment prospects once they return to their home country. Requires prior consent from the student's advisor and from the director of graduate studies. Credit/no credit grading only.

Grading Basis

Credit / No Credit

Course Typically Offered

Fall and/or Spring

Units

Min Units:
1

Max Units:
3

ECE899 - Special Readings in Electrical Engineering

Course Description
Special individual readings in a specified area of study in electrical engineering. Approval of director of graduate studies required.

Grading Basis
Graded

Units

Min Units:
1

Max Units:
4

ECE590-1 - Advanced Topics in Electrical and Computer Engineering

Course Description
Opportunity for study of advanced subjects in electrical and computer engineering.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
1

Max Units:
1

EGR505 - Oral Communication Skills for Engineers

Course Description
Designed for graduate engineering students who are non-native English speakers. Gain the skills necessary to confidently navigate the use of oral English. Learn social and academic norms needed for academic success and build interactional competence. Learn to deliver a self-introduction, brief overview of research/degree program/professional experience, and navigate small talk and social interactions through the development of cultural contexts and an understanding of conversational mechanics. Build the skills needed to actively participate in classes, seek help from multiple sources, and navigate productive interactions with faculty. Open only to Pratt graduate students.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

EGR506 - Academic & Professional Writing for Engineers I

Course Description
This writing course is designed for graduate engineering students who are non-native English speakers. The focus will be on writing and revising such that the results are clear and concise. Students will produce a variety of academic and professional documents pertinent to engineers. Additionally, students will analyze the written work of peers and provide relevant feedback. Open only to Pratt graduate students.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

EGR545 - Design Climate I: Discover

Course Description
Over the two-semester Design Climate course sequence, student teams use Design Thinking to create triple bottom line startups to address climate challenges posed by industry professionals or faculty. In Design Climate I (fall), student teams develop business ideas by working through the first three phases of Design Thinking: stakeholder empathizing, opportunity definition, and solution ideation. The semester culminates with a pitch on the startup idea that will be further vetted in Design Climate II (spring). Through this process, students learn directly from industry professionals and cultivate capabilities in Design Thinking, entrepreneurship, project management, sustainable product development, climate fundamentals, and business competencies. For more information, visit our website at https://designclimate.duke.edu. We highly encourage students to only register if you plan on taking both Design Climate I and II.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENVIRON545 DESIGN CLIMATE I: DISCOVER, I&E545 DESIGN CLIMATE I: DISCOVER

General Education Curriculum Codes
R - (R) Research

EGR546 - Design Climate II: Develop

Course Description
Over the two-semester Design Climate sequence, student teams use design thinking to develop triple bottom line startups that address climate challenges posed by industry professionals or faculty. In Design Climate II, student teams develop their business ideas by prototyping, gathering market validation data, and developing their business model. The semester culminates in a pitch of the startup ideas to members of the entrepreneurship community. Students cultivate capabilities in design thinking, entrepreneurship, project management, sustainable product development, climate fundamentals & business competencies. Includes local field trips.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ENVIRON546 DESIGN CLIMATE II: DEVELOP, I&E546 DESIGN CLIMATE II: DEVELOP

EGR590 - Special Topics in Engineering

Course Description
Subjects of an interdepartmental nature in engineering tailored to the advanced undergraduate student or first- or second-year graduate student. Instructor consent is required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1.5

Max Units:
3

EGR705 - Academic Presentations for Engineers

Course Description
Course designed for graduate engineering students who are non-native English speakers. Gain the skills necessary to deliver successful engineering-specific presentations. Through feedback, you will learn your strengths and weaknesses and will develop as a successful speaker. Practice delivering both short-form presentations and longer form formal presentations, as required by your particular field of study in engineering. Where possible, presentation practice in class will be related to your engineering course work.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

EGR706 - Academic & Professional Writing for Engineers II

Course Description
This writing course is designed for graduate engineering students who are non-native English speakers. The focus will be on writing and revising that result in clear, effective and concise products. Students will produce a variety of academic and professional documents pertinent to engineers. Additionally, students will analyze the written work of their peers and provide them with relevant feedback.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

EGR790 - Special Topics in Engineering

Course Description
General engineering topics intended for graduate students only, and interdepartmental in nature. Instructor consent is required.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
3

EGR790S - Special Topics in Engineering for Graduate Students

Course Description
Study arranged on broad engineering topics in which the faculty have a particular interest and competence as a result of research or professional activities. Instructor consent is required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1.5

Max Units:
3

EGR590-1 - Special Topics in Engineering

Course Description
Subjects of an interdepartmental nature in engineering tailored for entry-level graduate students.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
3

EGR790-1 - Special Topics in Engineering

Course Description
Subjects at an intermediate or advanced level in engineering that are interdepartmental in nature. Courses tailored to graduate students that have the introductory knowledge required. Variable Credit.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
3

EGRCOOP501 - Engineering Graduate Cooperative Education 1

Course Description
Students gain practical engineering experience by participating in a cooperative education work assignment involving a well-defined set of tasks or objectives. Prerequisite: Enrollment in the Master of Engineering Management or Master of Engineering co-op program.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
9

Max Units:
9

EGRCOOP502 - Engineering Graduate Cooperative Education 2

Course Description
Students gain practical engineering experience by participating in a cooperative education work assignment involving a well-defined set of tasks or objectives. Prerequisite: EGRCOOP 501 and Enrollment in the Master of Engineering Management or Master of Engineering co-op program.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
9

Max Units:
9

EGRCOOP503 - Engineering Graduate Cooperative Education 3

Course Description

Students gain practical engineering experience by participating in a cooperative education work assignment involving a well-defined set of tasks or objectives. Prerequisite: EGRCOOP 502 and Enrollment in the Master of Engineering Management or Master of Engineering co-op program.

Grading Basis

Credit / No Credit

Units

Min Units:

9

Max Units:

9

EGRMGMT501 - Engineering Management Seminar

Course Description

Current topics in applied engineering management and entrepreneurship. Weekly seminar series. Credit/No credit.

Grading Basis

Credit / No Credit

Course Typically Offered

Fall and/or Spring

Units

Min Units:

0

Max Units:

0

EGRMGMT504 - Residency 1 - Introduction

Course Description

One-week course to introduce the Master of Engineering Management Program. Residency 1 includes an orientation to Duke and the program, business simulations, case studies, professional development workshops and alumni engagement opportunities. Prerequisite: enrollment in the Master of Engineering Management Online Program.

Grading Basis

Credit / No Credit

Course Typically Offered

Fall Only

Units

Min Units:

0

Max Units:

0

EGRMGMT505 - Residency 2 - Mid-Program

Course Description

One-week course to assess interim progress for the Master of Engineering Management Online Program. Residency 2 includes team-building exercises, case studies, leadership training, workshops, seminars and engagement opportunities. Prerequisite: EGRMGMT 504.

Grading Basis

Credit / No Credit

Course Typically Offered

Fall Only

Units

Min Units:

0

Max Units:

0

EGRMGMT506 - Residency 3 - Conclusion and Graduation

Course Description
One-week course to conclude the Master of Engineering Management Online Program. Residency 3 includes internship presentations, team-building exercises, case studies, leadership training, professional development workshops, exit interviews, and graduation activities. Prerequisite: EGRMGMT 505.

Grading Basis
Credit / No Credit

Course Typically Offered
Spring Only

Units

Min Units:
0

Max Units:
0

EGRMGMT510 - Marketing

Course Description
Review basic concepts in marketing; marketing of high tech products and services. Product development with short life cycles, selling into complex supply chains, building advantage through innovation, the role of the customer in high tech and technology-intensive service industries, and marketing in volatile environments. Prerequisite: enrollment in the Master of Engineering Management Program.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT512 - Product Management in High-Tech Companies

Course Description
Students will explore the entire product management challenge in a way that goes beyond the typical MBA product marketing and brand management course with emphasis on managing products & services in a high tech environment. The course provides an in-depth exposure to the analyses, decisions, and implementation issues relevant to a typical product manager in a high tech company and prepares students for their first industry product management opportunity. This course is the first step in developing the set of skills needed for a successful product manager utilizing a mix of individual and team-based assignments, case analysis and presentations, computer simulations and projects.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT513 - Product Development

Course Description
This course aims to build students' understanding about the product or service development process and the factors influencing its execution. The transformation of an innovative idea into a product or service involves several phases — discovery, definition, development, demonstration, qualification, deployment and life cycle management — as well as balancing the external factors that impact these phases, depending on the unique product or service. Adequate management of these factors enables the development process to be executed on time and on budget while meeting customer needs and stakeholder expectations.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

EGRMGMT514 - Negotiations and Consultative Selling in Technology

Course Description

Skills in negotiations and consultative selling are required. From making a decision that affects internal operations, presenting a proposal to one's boss, or closing a sale with a major client, it is vital to have a strong set of skills to achieve our objectives. Focusing on two primary areas of influence and communication within business—negotiations and consultative selling (working collaboratively with others to effectively meet customer needs), this course covers the structured processes, theoretical constructs, and practical applications required to understand a complex situation and develop the negotiation or sales process most needed for value creation and goal attainment.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

EGRMGMT520 - Intellectual Property, Business Law, and Entrepreneurship

Course Description

Basic principles of intellectual property law, especially patent law but including trademark and copyright law, together with an overview of business law and the formation of new technical enterprises. Consideration of regulatory law, contract law, and product liability. Licensing and the use of the patent database in technological development. Prerequisite: enrollment in the Master of Engineering Management Program.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

EGRMGMT530 - Finance in High Tech Industries

Course Description

Review basic concepts of financial accounting and finance, with an emphasis on accounting needed for effective financial analysis. Focus on issues of finance in high tech industries. Emphases will include project financing, notions of options as applied to internal financial analysis, allocation of costs and revenues for new high tech projects, valuing projects and valuing firms when intellectual assets are a significant portion of total level value; corporate control in high tech firms. Finance issues in mergers, acquisitions, and alliances. Prerequisite: enrollment in the Master of Engineering Management Program.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT532 - Advanced Corporate Finance for Technology-Based Companies

Course Description

The focus of this course will be on major financial decisions of established technology corporations as well as entrepreneurial ventures. Analytical models and theories will be covered via problems and cases. Specific areas will include asset management, short-term and long-term borrowing, advanced capital budgeting strategies, determination of capital structure, dividend policy, international issues, and mergers and other forms of restructuring. Prerequisite: enrollment in the Master of Engineering Management Program.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

EGRMGMT534 - Quantitative Financial Analysis for Technology-Driven Investment Decisions

Course Description
In this introductory quantitative finance course, students will learn to build practical financial models using MS Excel spreadsheets. Investment banks, hedge funds, and money managers make buy and sell decisions based on computational models. This course starts with the most basic, and most important, portfolio and investment models used to evaluate risk and identify profit opportunities. Using Excel, students will learn how to build these models themselves, and to understand the decision-making inputs used by professional investors. The course's practical focus utilizes today's computationally sophisticated tools to analyze stock prices, bonds, options, and other financial instruments.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT540 - Management of High Tech Industries

Course Description
The purpose of this course is to empower students to become collaborative, ethical leaders in the globalized, 21st-century workplace. Students learn concepts and practice skills that will enable them to transition from being an engineering sole contributor to managing and leading others as a business professional. Students gain a sound understanding of management and leadership; increase awareness of their own management and leadership styles; build and practice competencies essential for team success (e.g., effective communication, collaboration, conflict resolution); and become ethical leaders above reproach. Emphasis is on leading teams in a volatile, complex and interdependent world.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

EGRMGMT542 - Competitive Strategy in Technology-Based Industries

Course Description
This course is designed to teach the elements of competitive strategy with a focus on the special considerations of technology-based companies, with particular emphasis on innovation and entrepreneurial activities in ventures of all sizes. Students will gain an appreciation for the strategic considerations that affect the success of technology-based products in the marketplace through a systematic exposure to key concepts in analysis, formulation and execution of strategic options. The course is structured along the lines that a company or organization would likely follow in the development of a competitive strategy.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

EGRMGMT550 - Engineering Management Internship

Course Description
A three-credit internship which requires participation with a cooperating organization, whether local or distant, involving a well-defined set of tasks. Full-time employment in an appropriate capacity may be utilized for this internship. This course is a required co or prerequisite for Engineering Management 551. Prerequisite: Enrollment in the Master of Engineering Management Program.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

EGRMGMT551 - Engineering Management Internship Assessment

Course Description
This course involves the assessment of a student's internship experience via a report and oral presentation. The questions and general format of the report and presentation will be provided by the instructor. The report and presentation will be evaluated by the instructor and both must be approved to obtain credit for this course. Students must have completed or be simultaneously enrolled in Engineering Management 550 which is a course designated for the internship experience. Prerequisite: Enrollment in the Master of Engineering Management Program.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

EGRMGMT552 - Engineering Management Supplemental Internship

Course Description
Students gain practical engineering experience by participating in an internship. The internship requires participation with a cooperating organization, whether local or distant, involving a well-defined set of tasks. Part-time or full-time employment in an appropriate capacity may be utilized for this internship and what is permitted may depend on the term the class is offered. Enrollment in the Master of Engineering Management Program is required. This is supplemental, elective internship and completion of the required internship. EGRMGMT 550 is a prerequisite. Credit/no credit grading only. May be repeated with consent of program director or advisor.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

EGRMGMT556 - Engineering Management Practicum

Course Description
The Engineering Management Practicum provides a real life view of various challenges faced by organizations. Projects at the intersection of engineering and business will be chosen for this practicum. Students will work in teams and will conduct a mentored, semester-long project for an organization. The learning objectives of this course include: (i) learn how engineering and technology impact organizations and how they are integrated into an organization to achieve desired results; (ii) understand, through an experiential environment, how organizations function and the difference between theory and implementation in an organizational setting; and (iii) develop team based skills in an applied environment and learn how to communicate technical issues to a variety of personnel in an organization. Consent of instructor required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

EGRMGMT560 - Project Management

Course Description
Projects are one of the key mechanisms for achieving organizational goals and implementing change, whether it is the design and launch of a new product, the construction of a new building, or the development of a new information system. This course will focus on defining project scope, developing project plans, managing project execution, validating project performance and ensuring project control. Additional topics covered include decision making, project finance, project portfolio selection and risk management.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT562 - Operations Management

Course Description
Operations management involves planning and controlling the processes used to produce the goods and services provided by an organization. In essence, it is the management of all activities related to doing the actual work of the organization. Managing these processes can be quite challenging - they are often very complex, and can involve large numbers of people and facilities, huge volumes of materials and great distance. Objectives of the course are to: i) Introduce students to the functional area of operations and to increase their awareness of how a firm's operations interface with the other functional areas of the organization, ii) Familiarize students with the various issues and problems that traditionally arise in the management of operations within both manufacturing and service organizations, iii) Acquaint students with some of the terminology, modeling, and methodologies that often arise in the handling and resolution of operations issues and problem.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT563 - Supply Chain Management

Course Description
The objectives of this course are to develop conceptual and modeling skills for the student and provide practical problem-solving tools, applicable to the design and analysis of supply chains. Students will also identify how the existence of multiple (distinct) decision makers in the supply chain can create misaligned incentives that harm supply chain performance and then learn how to mitigate this problem. Examples will include technology supply chains, and supply chains for innovative products. The course will balance modeling/quantitative problem solving with conceptual frameworks. Prerequisite: Enrollment in the Master of Engineering Management Program or permission of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

EGRMGMT572 - Innovation Management in Technology-Based Organizations

Course Description
This course takes students through a variety of issues related to managing innovation in the context of a technology-based organization. This includes managing know-how and innovation processes as well as creating an organizational culture that fosters and supports innovation. Students study best practices and benchmarks but must develop their own approach to managing innovation given each unique situation, including the organizational strategy, the competitive landscape, the strengths/weaknesses of the employees involved, etc. Nonetheless, there are accepted practices and concepts that will help guide students in developing a deeper understanding of this area.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

EGRMGMT574 - Commercializing Technology Innovations: Turning Visions into Value

Course Description
This course is designed to demystify and unify the journey from idea creation to value extraction through the use of concrete tools and real-world exercise. Innovations have many sources (e.g., individuals, companies, universities, governments) and many vehicles for commercialization (e.g., licensing, new products, enhanced products, and new ventures). Through this course, students will learn to think more broadly about innovation and commercialization options and strategies. Prerequisite: enrollment in the Master of Engineering Management Program.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT575 - Software Quality Management

Course Description
This class is designed to help students understand what it takes to build software products and services that meet customer quality expectations from day one. It introduces students to five different business personas that play a key role in the software life cycle: customer, software engineer, software release/ quality manager, customer support engineer, and general manager. For each of these players, it reviews what they do and what is most critical to quality. The class also provides exposure to current industry practices, case studies, data analysis and guest speakers who can describe 'what a day in the life' of each of these personas looks like.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT576 - Design Thinking and Innovation

Course Description
Success of established companies and entrepreneurial ventures depends on their ability to identify customer needs and develop products and services to meet these needs effectively. A disciplined design thinking process leads to successful innovations, particularly with regard to value creation and market impact. Starting with an understanding of empathy, ethnography, and interviewing, moving on to the iterative process of defining, ideating, prototyping, and testing, and then developing final designs, this course allows students to develop a deep set of skills in design thinking and innovation and includes current approaches such as agile development, biodesign, and lean startup.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT577 - Challenges and Strategies for the Design Thinker and Innovator

Course Description
Some designs withstand the test of time and survive hundreds, if not thousands of years, while others receive huge up-front investments only to fantastically fail. Still other designs resonate in the marketplace to such an extent that they become household names. Design team leaders confront a dizzying array of priorities, many dictated by industry standards as well as legal requirements that protect health, safety, and even civil rights. Through case studies and primary sources, this course explores the multifaceted challenges that confront design thinkers and innovators as well as strategies for managers and their teams to support the pursuit of excellence in the design process.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

EGRMGMT578 - Designing Customer Experiences in Technology

Course Description
Increasingly, the quality of a business's 'user experience' offerings provide the key to securing loyal customer relationships and sustainable market differentiation. Students are introduced to foundational design techniques and use case study discussions, readings, and hands-on projects to form a framework and 'personal toolkit' for designing compelling customer experiences. In addition, students flesh out this framework through project-based assignments and presentations applying the principles of design thinking, human factors, design for usability, and interaction design to analyze, create, and present effective customer experience solutions.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT579 - Using Real-Time Data to Improve Customer Quality Experience

Course Description
This class is designed to help students understand what it takes to improve customer experience using data. Emphasis is placed on the collection and use of real-time data for transforming customer experience. Key topics covered include the customer experience life cycle, data management and types, data collection infrastructure, use of metrics to create insights, using python for data science, creation of machine learning algorithms to predict customer impacting events and using data to support the customer success business model. Finally, the class provides exposure to current industry practices, case studies, a comprehensive final project and industry guest speakers.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT580 - Decision Models

Course Description
Problems involving uncertainty and/or complex interactions can be too difficult to grasp intuitively. This course introduces spreadsheet modeling, simulation, decision analysis and optimization to represent and analyze such complex problems. First, the use of decision tress for structuring decision problems under uncertainty is discussed. Next, Monte Carlo simulation is used as a modeling environment, using add-in programs as necessary. Prerequisite: Familiarity with Excel, enrollment in the Master of Engineering Management program, or permission of instructor.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT581 - Managing Product Design: Concept to Realization

Course Description
Managing Product Design: Concept to Realization is an opportunity for students to gain practical experience creating a business and managing a design team that produces a real product under realistic cost, schedule, and performance constraints. Students will form a semester-long 'company' that will create coherent business and technical strategies, and design, build, and demonstrate a functional product prototype. Teams will be assisted by managing external technical resources and receiving feedback and guidance from an advisory board.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT585 - Fundamentals of Data Science in Engineering Management

Course Description
In this course, students will learn the fundamentals of data science, including core technical vocabulary and mathematical concepts. This will include topics such as (i) probability through Bayesian techniques; (ii) binary classification; (iii) linear regression for forecasting; (iv) Information measures used in data science, including mutual information, relative entropy (KL divergence), and log loss (cross entropy), (v) Experimental design; and (vi) the roles of training and test data, using Hoeffding's inequality to forecast error rates. Students will apply the above concepts to real-world data, while developing their own models for probabilistic forecasting.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

EGRMGMT587 - Data Visualization for Engineering Managers

Course Description
Students learn best practices for presenting discoveries and 'calls to action' that are the primary aims of business data analysis. Learning about human visual perception, in particular the science of how choice of color, form, and other design elements can assist pre-attentive information processing. Origins of modern data-visualization in the pre-computer age are considered, starting with the use of overlay maps, and Galton's Quincunx and Correlation Diagram. Students learn to recognize the most commonly utilized types of data-visualization metaphor, as well as rules of thumb for various types of data analysis. No prior software experience required.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

EGRMGMT588 - Machine Learning Principles and Applications for Engineering Managers

Course Description
This course focuses on understanding how machine learning (ML) works and case studies of its successful application to a wide range of problem types, from better forecasting customer behavior, to playing Go, to responding appropriately to human speech. Students will learn the basic mathematical principles behind establishing reliable ML performance, and have an opportunity to experiment with various ML algorithms and observe how they perform on real-world data. The course does not require any prior programming experience. Recommended prerequisite: an introductory data science course.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

EGRMGMT590 - Advanced Topics in Engineering Management

Course Description
Opportunity for study of advanced subjects related to programs within engineering management tailored to fit the requirements of a small group. Permission of instructor required.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

EGRMGMT591 - Special Readings in Engineering Management

Course Description
Individual readings in advanced study and research areas of engineering management. Consent of instructor required.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
1

Max Units:
3

ENRGYEGR531 - Power Electronic Circuits for Energy Conversion

Course Description
Efficient conversion of electrical energy is critical for electric and hybrid vehicles, wind and solar energy, power grids, computers, medical devices, and portables. This course teaches analysis and design of power electronic circuits for energy conversion, including circuit operation (converter topologies, steady-state modeling, switch realization), converter control (ac modeling, small-signal transfer functions, feedback), and magnetics (inductors, transformers). The course shares lectures with ECE/Energy Engineering 431, but has extended assignments. Prerequisite: ECE 230L or Engineering 224L or graduate student standing. Not open to students who have taken ECE 431 or Energy Engineering 431.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ECE531 PWR CKTS FOR ENERGY CONVERSION

ENRGYEGR590 - Special Topics in Energy Engineering

Course Description
Study arranged on a special topic in which the instructor has particular interest and competence. Topics vary by section.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

FINTECH501 - Financial Technology Seminar

Course Description
Current topics in applied financial technology and entrepreneurship. Weekly seminar series. Credit/No credit.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
0

Max Units:
0

FINTECH502 - FinTech Capstone

Course Description
This course is a culmination of the FinTech program and will focus on developing solutions to a real world problem. For example, sufficient retirement income is an increasingly pressing problem in the United States and most developed countries given growth in retirement age, health care cost and quality, with corresponding longevity of the population. In order to obtain solutions that are economically and operationally feasible there is a need to understand, through forecasting techniques, the probable outcomes, with an eye towards both sides of the balance sheet. This will ensure that solutions created do not operate in a vacuum that fails to account for Global economic environment.

Grading Basis
Graded

Course Typically Offered
Fall and Summer

Units

Min Units:
3

Max Units:
3

FINTECH504 - Introductory Residency

Course Description
One-week course to introduce the Master of Engineering FinTech Online Program. Residency 1 includes an orientation to Duke and the program, business simulations, case studies, professional development workshops and alumni engagement opportunities. Open only to students in the Master of Engineering FinTech Online Program.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall Only

Units

Min Units:
0

Max Units:
0

FINTECH505 - Mid-Program Residency

Course Description
One-week course to assess interim progress for the Master of Engineering FinTech Online Program. Residency 2 includes team-building exercises, case studies, leadership training, workshops, seminars and engagement opportunities. Prerequisite: FINTECH 504. Open only to students in the Master of Engineering FinTech Online Program.

Grading Basis
Credit / No Credit

Course Typically Offered
Occasionally

Units

Min Units:
0

Max Units:
0

FINTECH506 - Concluding Residency

Course Description
One-week course to conclude the Master of Engineering FinTech Online Program. Residency 3 includes internship presentations, team-building exercises, case studies, leadership training, professional development workshops, and exit interviews. Prerequisite: FINTECH 505. Open only to students in the Master of Engineering FinTech Online Program.

Grading Basis
Credit / No Credit

Course Typically Offered
Spring Only

Units

Min Units:
0

Max Units:
0

FINTECH510 - Programming for FinTech

Course Description
This class is aimed at students who want to focus on financial technology (FinTech) but who may not have a programming or even technical background. This course will bring students up to speed on programming, data structures, and algorithms. C++ is the language of choice in this class because C and C++ are very commonly used by computer engineers.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

FINTECH511 - Data Wrangling and Visualization

Course Description
Students will leverage Python as an essential tool to query, clean, manipulate, and visualize data. The Python package 'pandas' provide a powerful way of organizing data values within a dataset. In addition to the data cleaning and transformation tasks, which represents a substantial portion of data scientists' time, the course deals with databases and web scraping. Students will learn how to connect to standard relational databases (MySQL, NoSQL) and to scrape unstructured (text) data from the web and query APIs. The course will also focus on using visualization before the data preprocessing to identify problems to tackle and after the preprocessing to recognize meaningful insights.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

FINTECH512 - Software Engineering for FinTech

Course Description
This course focuses on moving from small-to-medium software projects, to the design ideas required for larger scale, maintainable code. We will start with core design principles, which we will see manifest in a variety of the forms through the course of the semester. We will see these ideas emerge from smaller scale design at the start of the semester to large scale system architecture at the end. Testing will also be an important topic throughout. Prerequisite: FINTECH 510

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

FINTECH513 - Fintech Product Development

Course Description
This course will equip practitioners with tools to build compelling products that transform or disrupt longstanding financial services industry paradigms. Students will explore the process of product development and how it connects with FinTech, including user-centered design, the role of empathy, agile development, and collaboration within high-performing teams. Topics will focus on the skills needed to thrive in FinTech product development by investigating the business model, industry, and regulatory landscape and the key topics of data, AI, and responsible product development. Students will put their learnings into practice by examining market entry, scaling, and risk management.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

FINTECH514 - Secure Software Development

Course Description
This course is about minimizing risk when creating software and will focus on the fundamental structure of a Secure Development Life Cycle (SDLC), the advantages and challenges of cryptography, then explore automated testing solutions. Students will learn to effectively manage risk in the process of creating software. Hands-on experience with specific technologies prepare students to make informed decisions about the design, architecture, and implementation of software. Assignments use automated vulnerability hunting tools. Students will learn the risk profile of the target software project, and an understanding of how these tools add value to the overall secure development life cycle.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
CYBERSEC535 SECURE SOFTWARE DEVELOPMENT

FINTECH520 - Financial Institution Products & Services

Course Description
The course will provide students with an understanding of finance and financial concepts, with emphasis on innovation and technological changes. Study includes the maturation of products and services used by financial services firms, the monetary and financial system, the structural position of institutions comprising the financial services industry and their businesses, and 'non-banks'. Students will acquire skills to develop interest rate forecasting models, asset management methodologies, and time value of money applications. A review of the role of industry vendors/utilities will complete an understanding of this environment.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

FINTECH522 - Asset Pricing and Risk Management

Course Description
Much of financial valuation is based on the trade-off between returns (i.e., profit) and risk (i.e., volatility of returns). This core understanding of the correlation between return and risk permeates all areas of finance from banking to brokerage to investment management. The primary purpose of Asset Liability Management within banking is to ensure that the bank is sufficiently capitalized to provide a cushion for risk exposure, while continuing to enable growth and profitability. In this course, students will learn about various financial, macroeconomic, business, and technology risks, as well as the tools and methodologies for quantitative assessment of risk and performance.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

FINTECH533 - Design and Testing of Algorithmic Trading Systems

Course Description
This course introduces students to the tools, concepts, and workflow used by industry to craft algorithmic trading systems, as well as the financial concepts involved. Using the Python Dash framework, students will build simple but powerful trading apps that fetch data, pass trade orders, and evaluate performance metrics. Students will gain exposure to modern Python data analytics packages, GitHub Actions, market data feeds, web scraping, and trade execution system APIs. The course assumes an entry-level understanding of Python and finance and is intended for students who wish to take their skills to the next level.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

FINTECH534 - Quantitative Financial Analysis for Technology-Driven Investment Decisions

Course Description

An introduction to the most important concepts used in quantitative finance. Students will learn to build practical financial models using MS Excel spreadsheets. This course starts with the most basic, and most important, portfolio and investment models used to evaluate risk and identify profit opportunities. Using Excel, students will learn how to build these models themselves, and to understand the decision-making inputs used by professional investors. The course has a practical focus—how to analyze prices of stocks, bonds, options and other financial instruments using the types of computationally sophisticated tools in wide use today.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

FINTECH535 - Advanced Design and Testing of Algorithmic Trading Systems

Course Description

This course is intended for students who are already comfortable with Python Dash, have some knowledge of finance, trading, and market data, and wish to take a deep dive into the development and evaluation of one trading strategy. Forming teams of 2 to 4, students will produce a Python trading app which implements the team's strategy to process incoming data into actionable trade orders, pass the orders to a professional execution system, and visualize results and performance metrics as a dynamic web page. At the end of the semester, each team will present their strategy and results to Duke faculty and industry professionals at the annual Alpha Summit event. Prerequisite: Financial Technology 533.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

FINTECH536 - Robo-Advising: The Future of Investing?

Course Description

Robo-Advice brings investment services to a wider audience at lower costs compared to human advisors. Students will construct a very basic advisor using the Python programming language. This will be a short experiential case study with an open source Python code. Student teams will develop a comprehensive venture capital investment memorandum for a real-world Robo-Advising startup. Teams will analyze the Robo-Advisor's market environment, including the financial services industry, wealth management segments, competitors and channels; and, internal company characteristics, such as business strategy, asset allocation and portfolio composition, cost of customer acquisition, and financials.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

FINTECH540 - Machine Learning for FinTech

Course Description
Explores the history, current environment, and near-term outlook of Machine Learning, focusing on the applications within financial innovation (FinTech). The course provides hands on experience in applying machine learning tools in a number of situations, as well as understanding the applications across finance. This class will delve into elements of the current environment of Fintech and how machine learning has contributed to the disruption. The goal of this course is that students leave with not only knowledge but hands on experience implementing machine learning to solve problems and observe how this tool works and where the present and future value may be.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

FINTECH545 - Quantitative Risk Management

Course Description
Quantitative Risk Management offers a hands-on introduction to the science and implementation of risk analytics. Topics include probability theory, regression and time series analysis, risk metrics such as Value at Risk and Excepted Shortfall, derivative valuation methods, stress testing and scenario analysis, factor models, and portfolio construction and optimization.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

FINTECH550 - Emerging Trends for FinTech

Course Description
This class will study the environment of FinTech services to understand and acquire assessment techniques to model the motivation behind, for example: individual companies and offerings, the technology that has enabled many of these companies, and the business models that frequently challenge the customer service status quo. Applications of Game Theory—the ways in which businesses compete in the financial marketplace—will provide significant insights into the strategic behavior of current and future FinTech companies. The ever-increasing pace at which technology disrupts long standing business models will be reviewed in terms of both past, current, and possible future applications.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

FINTECH552 - FinTech Business Models

Course Description
The goal of this course is for students to understand the business models in the major FinTech value chain segments (businesses include, but are not limited to, marketplace lending, neo-banking, robo-advisory, crypto currency and other blockchain applications). In this course, we analyze the business models of selected FinTech companies with a special focus on the role of data. In some industries, such as banking, data has spurred and supported the new business models of the FinTechs. Therefore, data is most relevant for creating an overview of the actors in the FinTech, and broader financial services, ecosystem.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

FINTECH564 - Blockchain

Course Description
Blockchain technology is being embraced in finance and other industries as an encryption base for all types of applications. This course explores the history, current environment, and near-term outlook of financial innovation (FinTech), focusing on applications of Blockchain technology. Topics range from digital stores of value to documents and transactions. Students will learn to formulate an accurate image and deep practical understanding of the capabilities and limitations of various blockchain techniques. Students will gain hands on experience creating a simple Blockchain contract and will be able to converse on a practical basis about what Blockchain can and cannot do.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

FINTECH565 - Advanced Blockchain - Smart Contacts and Solidity Coding

Course Description
This course follows the basic blockchain course to provide students hands on experience and instruction in Solidity coding via a number of exercises and programming assignments. These provide a basis from which students will be introduced to the details of smart contracts and the application of the coding skills acquired to develop and deploy these programs. Deployment will be primarily via public blockchains using developer functions. Prerequisite: Financial Technology 564.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

FINTECH590 - Advanced Topics in Financial Technology

Course Description
Opportunity for study of advanced subjects related to programs within financial technology tailored to fit the requirements of a small group. Permission of instructor required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

FINTECH591 - Special Readings in Financial Technology

Course Description
Individual readings in advanced study and research areas of financial technology. Consent of instructor required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

GAMEDSGN501S - Game Design, Development, & Innovation Seminar

Course Description
Weekly seminar series.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
0

Max Units:
0

GAMEDSGN520 - Fundamentals of Game Development

Course Description
Students learn fundamentals of development in a modern game engine (e.g., Unreal Engine). Students learn about 3D graphics concepts such as geometry, lighting, and materials, and translate those concepts into scene creation in the game engine. Students learn and apply other important game concepts like audio, physics, user interface creation, and interaction between game objects and the player.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

GAMEDSGN521 - Advanced Game Development

Course Description
Students learn advanced techniques for game development in a modern game engine (e.g., Unreal Engine). Students learn to write C++ code to provide custom functionality in their games not available by other means. Students learn to create more complex visual effects, as well as the basics of how to design and animate their own 3D models. Students will learn to network and optimize games.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

GAMEDSGN530 - Critical Analysis of Video Games

Course Description
Students learn about the history of games, the psychology of user engagement, the representation of different groups in games, user interface/user experience (UI/UX), how games are monetized, the different career options in the gaming industry and the connection of audio/visual elements to the narrative structure. Students analyze existing games in the framework of the topics discussed in class.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

GAMEDSGN552 - Business Fundamentals and Management Principles for Game Production II

Course Description
This course continues to build on the business and management foundations learned in GAMEDSGN 551. Students will explore marketing, sales, intellectual property, hiring, and working with publishers. This course provides the foundations for students to learn and apply these principles to their studios. In addition, students in the GDDI program would have been working as studios for three semesters. Team communication and leadership strategy needs to be evaluated and optimized. The materials covered and the assignments given should guide students through these crucial conversations. Students will learn about team dynamics, effective communication, and personal leadership development. The course aims to prepare students to lead high-performing teams in a dynamic game industry environment.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

GAMEDSGN590 - Advanced Topics in Game Design, Development & Innovation

Course Description
Opportunity for study of advanced subjects related to programs within Game Design, Development & Innovation tailored to fit the requirements of a small group. Permission of instructor required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

GAMEDSGN590L - Advanced Topics in Game Design, Development & Innovation (with Lab)

Course Description
Opportunity for study of advanced subjects with laboratory related to programs within Game Design, Development & Innovation tailored to fit the requirements of a small group.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

GAMEDSGN591 - Special Readings in Game Design, Development & Innovation

Course Description
Individual readings in advanced study and research areas of Game Design, Development & Innovation. Consent of instructor required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

ME510 - Diffraction and Spectrometry of Materials

Course Description
This course focuses on the fundamentals and applications of x-ray/neutron/electron scattering for the study of materials, with an emphasis on crystalline solids. The class will cover topics in diffraction for the study of the atomic structure of materials, as well as spectrometry to investigate microscopic dynamics and composition. The students should have a background in solid state physics/chemistry, quantum mechanics, materials science, and mathematics including Fourier transforms and complex numbers, convolution product. Open to graduate students; instructor consent required for undergraduate students to enroll.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ME511 - Computational Materials Science

Course Description
This course will cover modern computational techniques for the prediction of materials properties, beginning from the scale of electrons and atoms and connecting to materials challenges in experiments today. Subjects covered will include Schroedinger's equation and density functional theory, molecular dynamics, and so-called multiscale approaches to connect quantities computed at the nanoscale to macroscopic properties. The class will incorporate specific examples as explicit computer exercises. The course is expected to provide an atomic-scale understanding of materials for both students with a primarily computational interest and those students whose research is primarily experimental. Open to graduate students; instructor consent required for undergraduate students to enroll.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ME513 - Nanobiomechanics

Course Description
The course consists of didactic lectures and many laboratory demonstrations and real experiments done by the students themselves. Topics include: Principles of single-molecule force spectroscopy (SMFS), SMFS experimental techniques, resolution and resolution limitations; Entropic and enthalpic elasticity of (bio)polymers; Structure and nanomechanics of DNA, polysaccharides, and proteins; Mechanisms of spontaneous folding, misfolding and refolding of proteins; Chaperones-assisted protein refolding; Principles of computer modeling of biopolymer mechanics; Development and characterization of novel, protein-based nanostructured, rationally designed biomaterials with unique mechanical properties. Open to graduate students; instructor consent required for undergraduate students to enroll.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ME514 - Properties and Characterization of Polymeric Materials

Course Description

An introductory graduate-level course in soft condensed matter physics dealing with the synthesis, structure, and properties of polymers, biopolymers and polymeric materials. The course provides a brief introduction to polymer syntheses based on chemical reaction kinetics, it covers polymer characterization and a broad range of properties of polymers and polymeric materials, including solution properties, thermal properties, rheological and mechanical properties, and surface properties. Some topics will be explored in more detail through semester projects, presented at a Polymer Symposium at the end of the semester. Open only to graduate students.

Grading Basis

Graded

Course Typically Offered

Fall and/or Spring

Units

Min Units:

3

Max Units:

3

Crosslisted Courses

BME529 PROPER & CHARACT POLYMERIC MAT

ME516 - Thin-Film Photovoltaic Technology

Course Description

This course will focus in on a promising class of solar cells based on thin-film absorbers, some of which are already commercialized (e.g., CdTe, CIGS), while others are on the cutting edge of new photovoltaics technology (e.g., perovskites). The course will employ a combination of lecture, directed reading and hands-on approaches. The hands-on component of the course will involve fabricating PV devices and employing contemporary characterization and modeling tools to evaluate device performance. Specific techniques and the intellectual framework are more generally applicable to other PV and electronic devices. Recommended prerequisite: ECE 230 or related familiarity with electronic properties of materials. Open to graduate students; instructor consent required for undergraduate students to enroll.

Grading Basis

Graded

Course Typically Offered

Spring Only

Units

Min Units:

3

Max Units:

3

Crosslisted Courses

ECE516 THIN-FILM PV TECHNOLOGY

ME524 - Introduction to the Finite Element Method

Course Description

Investigation of the finite element method as a numerical technique for solving linear ordinary and partial differential equations, using rod and beam theory, heat conduction, elastostatics and dynamics, and advective/diffusive transport as sample systems. Emphasis placed on formulation and programming of finite element models, along with critical evaluation of results. Topics include: Galerkin and weighted residual approaches, virtual work principles, discretization, element design and evaluation, mixed formulations, and transient analysis. Prerequisites: a working knowledge of ordinary and partial differential equations, numerical methods, and programming in FORTRAN or MATLAB.

Grading Basis

Graded

Course Typically Offered

Spring Only

Units

Min Units:

3

Max Units:

3

Crosslisted Courses

CEE530 FINITE ELEMENT METHOD

ME525 - Nonlinear Finite Element Analysis

Course Description

Formulation and solution of nonlinear initial/boundary value problems using the finite element method. Systems include nonlinear heat conduction/diffusion, geometrically nonlinear solid and structural mechanics applications, and materially nonlinear systems (for example, elastoplasticity). Emphasis on development of variational principles for nonlinear problems, finite element discretization, and equation-solving strategies for discrete nonlinear equation systems. Topics include: Newton-Raphson techniques, quasi-Newton iteration schemes, solution of nonlinear transient problems, and treatment of constraints in a nonlinear framework. An independent project, proposed by the student, is required. Prerequisite: Civil and Environmental Engineering 530/Mechanical Engineering 524, or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
CEE630 NONLIN FIN ELEMENT ANALY

ME527 - Buckling of Engineering Structures

Course Description

An introduction to the underlying concepts of elastic stability and buckling, development of differential equation and energy approaches, buckling of common engineering components including link models, struts, frames, plates, and shells. Consideration will also be given to inelastic behavior, postbuckling, and design implications.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
CEE647 BUCKLING EGR STRUCTURES

ME531 - Engineering Thermodynamics

Course Description

Axiomatic formulations of the first and second laws. General thermodynamic relationships and properties of real substances. Energy, availability, and second law analysis of energy conversion processes. Reaction and multiphase equilibrium. Power generation. Low temperature refrigeration and the third law of thermodynamics. Thermodynamic design.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

ME532 - Convective Heat Transfer

Course Description

Models and equations for fluid motion, the general energy equation, and transport properties. Exact, approximate, and boundary layer solutions for laminar flow heat transfer problems. Use of the principle of similarity and analogy in the solution of turbulent flow heat transfer. Two-phase flow, nucleation, boiling, and condensation heat and mass transfer.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ME535 - Biomedical Microsystems

Course Description
he objective of the course is to introduce students to the interdisciplinary field of biomedical microsystems with an emphasis on biomedical microelectromechanical systems (bioMEMS) and microtechnologies. Topics include Scaling laws, Micropatterning of substrates and cells, Microfluidics, Molecular biology on a chip, Cell-based chips for biotechnology, BioMEMS for cell biology, Tissue microengineering, and Microfabricated implants and sensors. Open to graduate students; instructor consent required for undergraduate students to enroll.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ME536 - Compressible Fluid Flow

Course Description
Basic concepts of the flow of gases from the subsonic to the hypersonic regime. One-dimensional wave motion, the acoustic equations, and waves of finite amplitude. Effects of area change, friction, heat transfer, and shock on one-dimensional flow. Moving and oblique shock waves and Prandtl-Meyer expansion. Prerequisite: Mechanical Engineering 336L or equivalent.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ME538 - Physicochemical Hydrodynamics

Course Description
An introduction to the fundamental principles of physicochemical hydrodynamics with an emphasis on the coupling between transport processes and interfacial phenomena. Topics include Brownian motion and molecular diffusion, electrokinetics and electrohydrodynamics, capillary and wetting. Through homework sets and a course project, the students will develop physical intuition and scaling tools to single out the dominant physicochemical process in a complex system. Prerequisite: Mechanical Engineering 336L or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ME539 - Interfacial Transport Phenomena for Energy Technologies

Course Description
The main topics are transport phenomena taking place on interfaces in renewable/sustainable energy technology. These transport phenomena comprise of charge transport (ions, electrons), heat transfer, and mass transfer (e.g. diffusion), sometimes coupled with chemical reactions (e.g. catalytic, electrochemical, photochemical.). We will study these transport phenomena at interfaces, especially in the micro- and nano-scale and apply this knowledge to energy conversion and storage processes. These interfacial transport phenomena are essential for photovoltaic cells, fuel cells, batteries, solarthermal devices, thermoelectric devices, and many others. Open to graduate students; instructor consent required for undergraduate students to enroll. Recommended prerequisite: Mechanical Engineering 431 or equivalent.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ME541 - Intermediate Dynamics: Dynamics of Very High Dimensional Systems

Course Description
Dynamics of very high dimensional systems. Linear and nonlinear dynamics of a string as a prototypical example. Equations of motion of a nonlinear beam with tension. Convergence of a modal series. Self-adjoint and non-self-adjoint systems. Orthogonality of modes. Nonlinear normal modes. Derivation of Lagrange's equations from Hamilton's Principle including the effects of constraints. Normal forms of kinetic and potential energy. Component modal analysis. Asymptotic modal analysis.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
CEE625 INTERMEDIATE DYNAMICS

ME543 - Energy Flow and Wave Propagation in Elastic Solids

Course Description
Derivation of equations for wave motion in simple structural shapes: strings, longitudinal rods, beams and membranes, plates and shells. Solution techniques, analysis of systems behavior. Topics covered include: nondispersive and dispersive waves, multiple wave types (dilational, distortion), group velocity, impedance concepts including driving point impedances and moment impedances. Power and energy for different cases of wave propagation. Prerequisites: Engineering 244L and Mathematics 353 or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
CEE626 ENERGY FLOW & WAVE PROPAGATION

ME544 - Advanced Mechanical Vibrations

Course Description
Advanced mechanical vibrations are studied primarily with emphasis on application of analytical and computational methods to machine design and vibration control problems. Equations of motion are developed using Lagrange's equations. A single degree-of-freedom system is used to determine free vibration characteristics and response to impulse, harmonic periodic excitations, and random. The study of two and three degree-of-freedom systems

includes the determination of the eigenvalues and eigenvectors, and an in-depth study of modal analysis methods. The finite element method is used to conduct basic vibration analysis of systems with a large number of degrees of freedom. The student learns how to balance rotating machines, and how to design suspension systems, isolation systems, vibration sensors, and tuned vibration absorbers.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ME555 - Advanced Topics in Mechanical Engineering

Course Description
Opportunity for study of advanced subjects related to programs within mechanical engineering tailored to fit the requirements of a small group. Approval of director of undergraduate or graduate studies required.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
4

ME560S - Materials Science and Engineering Seminar

Course Description
This course is a seminar class open to all students with an interest in Materials Science & Engineering (MS&E) at Duke University. For the graduate students in the Duke University Program in MS&E (Masters and Ph.D. tracks), this seminar course is a mandatory component. The course generally consists of four external seminars (with Q&A opportunities for all interested students after the seminar) and of eight 'internal' meeting periods with presentations by Duke graduate students. Each internal seminar course session will generally feature one 'journal' presentation and one 'original research' presentation, designed for twenty minutes presentation time plus discussion.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
1

Max Units:
1

ME562 - Materials Synthesis and Processing

Course Description
Materials form the basis of most modern technologies, whether referring to energy, data processing, medical/health or consumer product application. While materials properties are central to the application, the techniques used for processing functional materials into films, crystals or bulk form, with carefully tailored properties, is no less important and will form the basis of the class. Additionally, the course will expose students to current materials processing/application research thrusts at Duke.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ME571 - Aerodynamics

Course Description
Fundamentals of aerodynamics applied to wings and bodies in subsonic and supersonic flow. Basic principles of fluid mechanics analytical methods for aerodynamic analysis. Two-and three-dimensional wing theory, slender-body theory, lifting surface methods, vortex and wave drag. Brief introduction to vehicle design, performance and dynamics. Special topics such as unsteady aerodynamics, vortex wake behavior, and propeller and rotor aerodynamics. This course is open only to undergraduate seniors and graduate students. Prerequisites: Mechanical Engineering 336L or equivalent, and Mathematics 353 or equivalent.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ME572 - Engineering Acoustics

Course Description
Fundamentals of acoustics including sound generation, propagation, reflection, absorption, and scattering. Emphasis on basic principles and analytical methods in the description of wave motion and the characterization of sound fields. Applications including topics from noise control, sound reproduction, architectural acoustics, and aerodynamic noise. Occasional classroom or laboratory demonstration. This course is open only to undergraduate seniors and graduate students. Prerequisites: Mathematics 353 or equivalent or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ME582 - Applications in Data and Materials Science

Course Description
AI principles will be applied to a series of materials science example problems, each taught in a module by an expert in materials science or data science. Each module will span 2-3 weeks, demonstrating an array of data science/AI methods in unique materials case studies in advancing discovery or design principles. Prerequisites: ME 221 or equivalent, introductory machine learning course.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
COMPSCI583 APPL IN DATA & MATERIALS SCI

ME591 - Research Independent Study in Mechanical Engineering or Material Science

Course Description
Research project mentored by an instructor with related interests and expertise. The project is expected to be graduate-level work. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ME592 - Research Independent Study in Mechanical Engineering or Material Science

Course Description
Research project mentored by an instructor with related interests and expertise. The project is expected to be graduate-level work. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ME593 - Research Independent Study in Mechanical Engineering or Material Science

Course Description
Research project mentored by an instructor with related interests and expertise. The project is expected to be graduate-level work. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ME594 - Research Independent Study in Mechanical Engineering or Material Science

Course Description
Research project mentored by an instructor with related interests and expertise. The project is expected to be graduate-level work. Instructor consent required.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

ME627 - Linear System Theory

Course Description
Construction of continuous and discrete-time state space models for engineering systems, and linearization of nonlinear models. Applications of linear operator theory to system analysis. Dynamics of continuous and discrete-time linear state space systems, including time-varying systems. Lyapunov stability theory. Realization theory, including notion of controllability and observability, canonical forms, minimal realizations, and balanced realizations. Design of linear feedback controllers and dynamic observers, featuring both pole placement and linear quadratic techniques. Introduction to stochastic control and filtering. Prerequisites: Electrical and Computer Engineering 382 or Mecahnical Engineering 344, or consent of instructor.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
CEE627 LINEAR SYSTEM THEORY

ME631 - Intermediate Fluid Mechanics

Course Description
A survey of the principal concepts and equations of fluid mechanics, fluid statics, surface tension, the Eulerian and Lagrangian description, kinematics, Reynolds transport theorem, the differential and integral equations of motion, constitutive equations for a Newtonian fluid, the Navier-Stokes equations, and boundary conditions on velocity and stress at material interfaces.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

ME634 - Turbulence 1

Course Description
This is an introductory course on the subject of turbulence in fluids. The focus is on understanding the fundamental physical processes and mechanisms governing the behavior of turbulent flows. The course covers the following - overview of physical and mathematical properties of Navier-Stokes equation; kinematics, dynamics and energetics of turbulent flows; Kolmogorov theories of turbulence; Richardson energy cascade; wall-bounded turbulent flows; particle dispersion, clustering and collisions in turbulent flows. Prerequisite: ((CEE 301L or ME 336L) and Mathematics 353) or graduate standing. Recommended prerequisite: an introductory course on fluid mechanics, and a course on differential equations.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
CEE688 TURBULENCE 1

ME639 - Computational Fluid Mechanics and Heat Transfer

Course Description
An exposition of numerical techniques commonly used for the solution of partial differential equations encountered in engineering physics. Finite-difference schemes (which are well-suited for fluid mechanics problems); notions of accuracy, conservation, consistency, stability, and convergence. Recent applications of weighted residuals methods (Galerkin), finite-element methods, and grid generation techniques. Through specific examples, the student is guided to construct and assess the performance of the numerical scheme selected for the particular type of transport equation (parabolic, elliptic, or hyperbolic).

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ME671 - Advanced Aerodynamics

Course Description
Advanced topics in aerodynamics. Conformal transformation techniques. Three-dimensional wing theory, optimal span loading for planar and nonplanar wings. Ground effect and tunnel corrections. Propeller theory. Slender wing theory and slender body theory, transonic and supersonic area rules for minimization of wave drag. Numerical methods in aerodynamics including source panel and vortex lattice methods. Prerequisite: Mechanical Engineering 571.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

ME672 - Unsteady Aerodynamics

Course Description
Analytical and numerical methods for computing the unsteady aerodynamic behavior of airfoils and wings. Small disturbance approximation to the full potential equation. Unsteady vortex dynamics. Kelvin impulse and apparent mass concepts applied to unsteady flows. Two-dimensional unsteady thin airfoil theory. Time domain and frequency domain analyses of unsteady flows. Three-dimensional unsteady wing theory. Introduction to unsteady aerodynamic behavior of turbomachinery. Prerequisite: Mechanical Engineering 571.

Grading Basis
Graded

Course Typically Offered
Occasionally

Units

Min Units:
3

Max Units:
3

ME676 - Advanced Acoustics

Course Description
Analysis methods in acoustics including wave generation, propagation, reflection, absorption, and scattering; sound propagation in a porous material; coupled structure acoustic systems; acoustic singularities: monopoles, dipoles, quadrupoles; radiation from flat surfaces; classical radiation and scattering solutions for cylinders and spheres; Green's functions, Radiation conditions, Modal analysis; sound fields in rooms and enclosures: energy methods; dissipation in fluid media; introduction to nonlinear effects. This course is open only to graduate students with some prior background in acoustics and applied mathematics. Prerequisites: Mechanical Engineering 572 or equivalent.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

ME711 - Nanotechnology Materials Lab

Course Description
This course provides an introduction to advanced methods for the characterization and fabrication of materials, nanostructures, and devices. Cleanroom methods to be covered include lithography, evaporation, and etching. Characterization methods include electron microscopy, atomic force microscopy, X-ray photoelectron spectroscopy, and optical spectroscopy. Students will receive an overview of the techniques in the Shared Materials Instrumentation Facility through lectures and demonstrations. In the lab section, each student will engage in a project that focuses on those capabilities that are needed for their research, and will receive training and certification on that equipment.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

Crosslisted Courses
ECE721 NANOTECHNOLOGY MATERIALS LAB

ME717S - Biological Engineering Seminar Series (CBIMMS and CBTE)

Course Description
Seminar series featuring in alternate weeks invited speakers and pre-seminar discussions. Research topics in biological engineering, with emphasis on bioinspired materials and materials systems, biomolecular, and tissue engineering. Enrollment is required of all BIMMS and BTE certificate program students in their first and second year. Open to others for credit or audit. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Fall Only

Units

Min Units:
1

Max Units:
1

Crosslisted Courses
BME711S BIOLOGICAL ENGINEERING SEM

ME718S - Biological Engineering Seminar Series (CBIMMS and CBTE)

Course Description
Seminar series featuring in alternate weeks invited speakers and pre-seminar discussions. Research topics in biological engineering, with emphasis on bioinspired materials and materials systems, biomolecular, and tissue engineering. Enrollment is required of all BIMMS and BTE certificate program students in their first and second year. Open to others for credit or audit. Instructor consent required.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
1

Max Units:
1

Crosslisted Courses
BME712S BIOLOGICAL ENGINEERING SEM

ME742 - Nonlinear Mechanical Vibration

Course Description
A comprehensive treatment of the role of nonlinearities in engineering dynamics and vibration. Analytical, numerical, and experimental techniques are developed within a geometrical framework. Prerequisite: Mechanical Engineering 541 or 544 or equivalent.

Grading Basis
Graded

Units

Min Units:
3

Max Units:
3

ME758S - Curricular Practical Training

Course Description
Curricular Practical Training. Student gains practical Mechanical Engineering and Materials Science experience by taking a job in industry and writing a report about this experience. Course requires prior consent from the student's advisor and from the Director of Graduate Studies and may be repeated with consent of the advisor and the Director of Graduate Studies.

Grading Basis
Credit / No Credit

Course Typically Offered
Occasionally

Units

Min Units:
1

Max Units:
3

ME759 - Special Readings in Mechanical Engineering

Course Description
Individual readings in advanced study and research areas of mechanical engineering. Approval of director of graduate studies required. 1 to 3 units.

Grading Basis
Graded

Units

Min Units:
1

Max Units:
3

ME775 - Aeroelasticity

Course Description
A study of the statics and dynamics of fluid/structural interaction. Topics covered include static aeroelasticity (divergence, control surface reversal), dynamic aeroelasticity (flutter, gust response), unsteady aerodynamics (subsonic, supersonic, and transonic flow), and a review of the recent literature including nonlinear effects such as chaotic oscillations. Prerequisite: Mathematics 230 and consent of instructor.

Grading Basis
Graded

Course Typically Offered
Spring Only

Units

Min Units:
3

Max Units:
3

ME789 - Internship in Mechanical Engineering

Course Description
Student gains practical mechanical engineering experience by taking a job in industry, and writing a report about this experience. Requires prior consent from the student's advisor and from the director of graduate studies. May be replaced with consent of the advisor and the director of graduate studies. Credit/no credit grading only.

Grading Basis
Credit / No Credit

Course Typically Offered
Occasionally

Units

Min Units:
1

Max Units:
3

MENG540 - Management of High Tech Industries

Course Description
The purpose of this course is to empower students to become collaborative, ethical leaders in the globalized, 21st-century workplace. Students learn concepts and practice skills that will enable them to transition from being an engineering sole contributor to managing and leading others as a business professional. Students gain a sound understanding of management and leadership; increase awareness of their own management and leadership styles; build and practice competencies essential for team success (e.g., effective communication, collaboration, conflict resolution); and become ethical leaders above reproach. Emphasis is on leading teams in a volatile, complex and interdependent world.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3

MENG549 - Career Preparation

Course Description
Students gain practical experience preparing to search for an internship and full-time opportunities. Course projects include preparing a resume, cover letter, social media profile; developing a concise description of role sought the skills and knowledge and experiences a student possesses to be successful in this role. Student also explore informational interviews, researching companies aligned to career interests; interview tips and techniques. Students also prepare t be successful in the internship through an introduction to company expectations, giving and receiving feedback; uses of influence and advocacy; presentation skills; and career management skills.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
0

Max Units:
0

MENG550 - Master of Engineering Internship/Project

Course Description
Students gain practical engineering experience by participating in an internship of project involving a well-defined set of tasks or objectives. Prerequisite: enrollment in the Master of Engineering Program or faculty permission.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall, Spring and Summer

Units

Min Units:
0

Max Units:
0

MENG550K - Master of Engineering Internship/Project

Course Description
Students gain practical engineering experience by participating in an internship of project involving a well-defined set of tasks or objectives. Prerequisite: enrollment in the Master of Engineering Program or faculty permission. Taught at Duke Kunshan University in Kunshan, China.

Grading Basis
Credit / No Credit

Course Typically Offered
Fall and/or Spring

Units

Min Units:
0

Max Units:
0

MENG551 - Master of Engineering Internship/Project Assessment

Course Description

Students will prepare a substantive assessment of their internship or project experience via a written report and/or oral presentation. Pre- or co-requisite: Completion of an internship or project. Prerequisite: enrollment in the Master of Engineering Program or faculty permission.

Grading Basis

Credit / No Credit

Course Typically Offered

Fall, Spring and Summer

Units

Min Units:

0

Max Units:

0

MENG552 - Master of Engineering Supplemental Internship

Course Description

Students gain practical engineering experience by participating in an internship. The internship requires participation with a cooperating organization, whether local or distant, involving a well-defined set of tasks. Part-time or full-time employment in an appropriate capacity may be utilized for this internship and what is permitted may depend on the term the class is offered. Enrollment in the Master of Engineering Program is required. This is a supplemental, elective internship and completion of the required internship. MENG 550 is a prerequisite. Credit/no credit grading only. May be repeated with the consent of the program director or advisor.

Grading Basis

Credit / No Credit

Course Typically Offered

Fall and/or Spring

Units

Min Units:

3

Max Units:

3

MENG553 - Master of Engineering Assessment

Course Description

Students will prepare a substantive assessment of their master's experience that demonstrates technical knowledge and communication skills.

Grading Basis

Credit / No Credit

Course Typically Offered

Fall and/or Spring

Units

Min Units:

0

Max Units:

0

MENG555 - Master of Engineering Internship Reflection and Assessment

Course Description

This course involves reflection and assessment of a student's internship experience via a report and/or oral presentation. Students must be enrolled in or have completed an external internship or Co-op while a student at Duke to participate in this class.

Grading Basis

Graded

Course Typically Offered

Fall and/or Spring

Units

Min Units:

3

Max Units:

3

MENG570 - Business Fundamentals for Engineers

Course Description
This comprehensive course examines core and evolving concepts in the business fundamentals of successful technology-based companies including Business Plan Development & Strategies, Marketing, Product & Process Development processes, Intellectual Property, Accounting, Finance, and Operations. Students will learn the fundamentals essential to understanding all aspects of a business and will be able to converse in some depth in each of the areas studied upon completion. Other topics will include Supply Chain Management, Stage-Gate Development Cycles, Balances Scorecards, Blue Ocean Strategy, and Disruptive Technologies.

Grading Basis
Graded

Course Typically Offered
Fall and/or Spring

Units

Min Units:
3

Max Units:
3