

Bulletin of Duke University



The Pratt School of Engineering
Professional Master's Programs
2023-2024

Duke University

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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 2023-2024 and is accurate and current, to the greatest extent possible, as of August 2023. 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.

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

About Duke University

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

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.

Duke University

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."

Duke University Leadership

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

Executive Leadership

Vincent Price, President | president.duke.edu

Daniel Ennis, Executive Vice President

Jennifer Francis, Interim Provost

A. Eugene Washington, Chancellor for Health Affairs, Duke University, President and CEO, DUHS

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

Gary Bennett, Dean, Trinity College of Arts and Sciences

William Boulding, Dean, Fuqua School of Business

Edgardo Colón-Emeric, Dean, Divinity School

Vincent Guilamo-Ramos, Dean, School of Nursing and Vice Chancellor for Nursing Affairs

Judith Kelley, Dean, Sanford School of Public Policy

Mary E. Klotman, Dean, School of Medicine

Jerome P. Lynch, Dean, Pratt School of Engineering

Toddi Steelman, Stanback Dean, Nicholas School of the Environment

Vice Provosts

Edward Balleisen, Vice Provost for Interdisciplinary Studies

Abbas Benmamoun, Vice Provost for Faculty Advancement

John Brown, Vice Provost for the Arts

Yakut Gazi, Vice Provost for Learning Innovation and Digital Education

Mohamed Noor, Interim Vice Provost for Academic Affairs

Mary Pat McMahon, Vice Provost/Vice President of Student Affairs

Amy Oates, Interim Vice Provost for Finance & Administration

Noah Pickus, Associate Provost

Joseph Salem, Rita DiGiallonardo Holloway University Librarian and Vice Provost for Library Affairs

Candis Watts Smith, Interim Vice Provost for Undergraduate Education

University Administration

Duke University

Pamela J. Bernard, Vice President and General Counsel

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 Satterfield, Vice President for Finance

Chris Simmons, Interim Vice President for Public Affairs & Government Relations

Russell Thompson, Interim Vice President for Operations

Neal Triplett, President, DUMAC

Stefanie Williams, Vice President for Durham & 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. Duke currently has two Nobel Laureates among its faculty. Many others hold appointments in the National Academy of Sciences. Their books and publications are numerous and influential.

Duke professors are also excellent teachers. There is an 8-to-1 ratio of students to faculty. Professors are committed to giving students the individual attention that pushes them to excel while nurturing their ideas. Undergraduates, even in their first year, interact with senior faculty on a regular basis in efforts such as the Focus Program, a series of first-year interdisciplinary seminars focused on a theme. In addition, many serve as advisors to students, including those who choose to design their program of study and as mentors to undergraduates who pursue hands-on research.

Profiles of Duke's faculty members are available via Scholars@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 the Commission on Colleges at 1866 Southern Lane, Decatur, Georgia 30033-4097 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 Diversity and Inclusion

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.

Excellence, Diversity, and Inclusion: A statement by the faculty, Provost, and President

Duke University

To achieve our mission and meet the needs of a rapidly changing world, Duke strives to create a climate of collaboration, creativity, and innovation within and across disciplines. Our success depends upon the robust exchange of ideas – an exchange that flourishes best when the rich diversity of human knowledge, perspectives, and experiences is heard. We nonetheless acknowledge that our policies and practices have often failed to ensure equality of participation within our community. Our renewed commitment and responsibility to one another is articulated in the following statement.

Duke University Community Commitment

Because diversity is essential to fulfilling the university's mission, Duke is committed to building an inclusive and diverse university community. Every student, faculty, and staff member —whatever their race, gender, age, ethnicity, cultural heritage or nationality; religious or political beliefs; sexual orientation or gender identity; or socioeconomic, veteran or ability status—has the right to inclusion, respect, agency and voice in the Duke community. Further, all members of the University community have a responsibility to uphold these values and actively foster full participation in university life.

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 the *The Duke Community Standard in Practice: A Guide for Students*.

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.

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For additional information about FERPA, see ed.gov/policy/gen/guid/fpco/ferpa/index.html. 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. The institution prohibits discrimination on the basis of age, color, disability, gender, gender identity, gender expression, genetic information, national origin, race, religion, sex, sexual orientation, or veteran status, in the administration of its educational policies, admission policies, financial aid, employment, or any other institution program or activity. It admits qualified students to all the rights, privileges, programs, and activities generally accorded or made available to students.

Sexual harassment and sexual misconduct are forms of sex discrimination and prohibited by the institution. 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. The Office for Institutional Equity is located in Smith Warehouse, 114 S. Buchanan Blvd., Bay 8, Durham, North Carolina 27708, and can be contacted at (919) 684-8222.

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

Discrimination in employment or educational 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

Additional information, including the complete text of Duke's Policy on Prohibiting Discrimination, Harassment and Related Misconduct and appropriate complaint procedures, may be found here. For further information visit the U.S. Department of Education Office for Civil Rights, or call 1-800-421-3481.

University Resources, Campus Life & Activities

Agreements with other Universities

Neighboring Universities (Interinstitutional Agreement)

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. Under the same conditions, one interinstitutional course per summer may be taken at a neighboring institution participating in this agreement provided that the student is concurrently enrolled at Duke for one full course credit. This agreement does not apply to contract programs such as the American Dance Festival or to study abroad programs.

Approval forms for courses to be taken at these neighboring institutions may be obtained from the offices of the academic deans and the university registrar. Forms are also available online at the Office of the University Registrar website (registrar.duke.edu), in the Registration section. Only those courses not offered at Duke will be approved. Approval must be obtained at Duke from the director of undergraduate studies of the subject of the course and the student's academic dean. 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. The courses may be eligible for Areas of Knowledge and Modes of Inquiry coding. The student pays any special fees required of students at the host institution.

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Courses taken at The University of North Carolina at Chapel Hill by Duke students in the Robertson Scholarship Program (a joint scholarship program for students at Duke and The University of North Carolina at Chapel Hill) are interinstitutional courses. However, the restriction on the number of courses and the kind of courses (i.e., those not offered at Duke) permitted does not always apply. Robertson Scholars should refer to program materials for specific regulations.

Domestic Exchange Programs

Trinity College has exchange programs with two domestic institutions: Howard University in Washington, DC, and Spelman College in Atlanta, Georgia. Duke students may study for a semester at either institution, while students from these institutions enroll for the same period at Duke. Students may enroll in a wide variety of courses at either Howard University or Spelman College for which they will receive transfer credit at Duke. Transfer credits earned under this exchange program do not count against the maximum allowable domestic or study abroad transfer credits. For more information about these programs, visit 011 Allen.

Career Center

The Career Center, working in partnership with faculty and colleagues, provides career advising to all Duke undergraduates, graduate students, and alumni. Recognizing the unique talents and needs of each individual, the Career Center encourages students to make the most of their Duke experience by accessing relevant campus resources, developing career interests and values, and establishing and maintaining important human relationships with their peers as well as Duke faculty, staff, and alumni. The Career Center works to build and maintain relationships with alumni and employers who can provide internships and learning opportunities, entry-level positions, and opportunities for experienced professionals. For more information, visit careerhub.students.duke.edu.

Continuing Studies

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 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 the Office of Continuing Studies and Summer Session, and are subject 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 through the Office of Continuing Studies for admission as a nondegree, full-time visiting student for one or two semesters. Students with unique circumstances should contact the Office of Continuing Studies.

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 Continuing Studies (see the Satisfactory Continuation Requirements outlined on page 51 of 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.

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Academic Probation	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• 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 from Duke Continuing Studies. 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 certificate programs offered include human resource management, management accounting, digital media and marketing, big data and data science, technical communications, business communications, business ethics, paralegal studies, financial planning, event development, Six Sigma Green Belt, entrepreneurship, supply side management, sustainable management, online learning, finance essentials, legal nurse consulting, and others.

Nonprofit Management Program

Students 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 fall and spring retreats, language tables, reading groups, film and lecture series, and volunteer opportunities.

Duke Youth Programs

For more than thirty-five years, Duke Youth Programs has offered academic enrichment opportunities for middle and high school students in the summer. Current offerings range from camps in biosciences and engineering, forensic science, game design, drones, math, cryptography, neurosciences, creative writing, SAT preparation, video production, and a college admissions boot camp.

For more information, call the Office of Continuing Studies and Summer Session at (919) 684-6259, or visit learnmore.duke.edu.

Institutes, Initiatives & Centers

University Institutes

- **Bass Connections** bridges the classroom and the world beyond the university, giving students from all of Duke's schools a chance to tackle complex societal problems alongside our superb faculty. For more information, visit bassconnections.duke.edu.
- **The Duke Global Health Institute (DGHI)** brings together knowledge and resources from across the university to address the most important global health issues of our time. DGHI faculty, staff and students are engaged in research and educational projects in more than 40 countries, including the United States. For more information, visit globalhealth.duke.edu.
- **The Duke Institute for Brain Sciences (DIBS)** provides a vibrant hub for all who share our vision of making neuroscience greater than the sum of its parts by integrating schools, disciplines, analysis and education to accelerate breakthroughs and benefit society. For more information, visit dibs.duke.edu.
- **The John Hope Franklin Humanities Institute (FHI)** is built on a fundamentally collaborative model befitting the Duke University emphasis on knowledge in the service of society. Through interdisciplinary cross-fertilization, we seek to encourage the conversations, partnerships, and collaborations that continually stimulate creative and fresh humanistic research, writing, teaching, and practice at Duke. For more information, visit fhi.duke.edu.

Duke University

- **The Kenan Institute for Ethics** is an interdisciplinary think and do tank committed to promoting moral reflection and commitment, conducting interdisciplinary research, and shaping policy and practice at Duke and beyond. For more information, visit kenan.ethics.duke.edu.
- **The Nicholas Institute for Energy, Environment & Sustainability** advances the university's mission to build a more sustainable world by developing transformative educational experiences; galvanizing and conducting impactful research; and engaging with key decision makers at the global, national, state, and local levels. For more information, visit nicholasinstitute.duke.edu.
- **The Social Science Research Institute (SSRI)** brings together researchers with interests in problems that cross the various social and behavioral sciences, including problems that connect with the humanities and natural sciences. For more information, visit ssri.duke.edu.

Initiatives

- **The Duke Initiative for Science & Society** ("Science & Society") fosters research, education, communication, democratic deliberation, and policy engagement on the ethical progress of science and technology in society. For more information, visit scienceandsociety.duke.edu.
- **Innovation & Entrepreneurship Initiative (I&E)** believes all Duke students benefit from learning about innovation and entrepreneurship—from those who wish to found a company, to those who want to change the world with innovation, to those who simply want to cultivate a more creative and entrepreneurial mindset. I&E partners with schools and departments across Duke to offer interdisciplinary, experience-based education. For more information, visit entrepreneurship.duke.edu.
- **MEDx** (Medicine + Engineering at Duke) was forged in 2015 to enhance existing ties and foster new interdisciplinary collaborations between the School of Medicine and Pratt School of Engineering. An initiative rather than an institute, MEDx is structured to enhance existing ties and encourage new collaborations among faculty from both schools as well as other schools, institutes and initiatives at Duke. For more information, visit medx.duke.edu.
- **The Rhodes Information Initiative at Duke (iiD)** is an interdisciplinary program designed to increase "big data" computational research and expand opportunities for student engagement in this rapidly growing field. For more information, visit bigdata.duke.edu.

Centers

- **The Center for Documentary Studies (CDS)** offers an interdisciplinary program in the documentary arts—photography, audio, film/video, narrative writing, new media, and other means of creative expression—that emphasizes active engagement in the world beyond the university campus. For more information, visit documentarystudies.duke.edu.
- **The Dewitt Wallace Center for Media and Democracy (DWC)** is Duke University's hub for the study of journalism. DWC studies the interaction between news media and policy, supports watchdog and accountability reporting in the United States and around the world, and teaches about the media's role in democracy. The center is part of the Sanford School of Public Policy, and shares in the Sanford School's mission of teaching, research, and policy engagement, with the goal of putting knowledge in service to society. For more information, visit dewitt.sanford.duke.edu.
- **Duke Civic Engagement (DCE)** strengthens and connects the ways in which Duke partners with communities. DCE supports Duke's collaborations on pressing social challenges by increasing the capacity of the campus to sustain partnerships and sharing best practices in community engagement. For more information, visit civic.duke.edu.
- **The Duke University Center for International and Global Studies (DUCIGS)** grounds its research, teaching, and programming on the deep, region and culture-specific knowledge and experience of its organizational units while exploring global topics, pursuing interdisciplinary and cross-regional collaboration, and welcoming new approaches within areas studies and global studies. DUCIGS is home to various international area studies centers, councils, and initiatives. Visit the DUCIGS website at igs.duke.edu to learn more about the many centers and initiatives it houses.
- **DukeEngage** provides fully-funded opportunities that enable students and faculty to collaborate with organizations across the globe to address critical societal needs through an immersive summer of civic engagement. For more information, visit dukeengage.duke.edu.
- **The Margolis Center for Health Policy** catalyzes Duke University's leading capabilities including interdisciplinary academic research and capacity for education and engagement, to inform policy making and implementation for better health and health care. The Center has offices and staff on Duke University's campus in Durham, North Carolina and at the Duke in DC offices in the heart of the nation's capital. For more information, visit healthpolicy.duke.edu.

Libraries & Technology

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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, the Pearse Memorial Library at the Duke Marine Lab 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.

All Libraries

- Perkins & Bostock Libraries (library.duke.edu)
- David M. Rubenstein Rare Book & Manuscript Library (library.duke.edu/rubenstein)
- Duke University Archives (library.duke.edu/rubenstein/uarchives)
- Lilly Library (library.duke.edu/lilly)
- Music Library (library.duke.edu/music)
- Marine Lab Library (library.duke.edu/marine)
- Library Service Center (library.duke.edu/lsc)
- Divinity School Library (library.divinity.duke.edu)
- Duke Kunshan University Library (dukekunshan.edu.cn/en/academics/library)
- Ford Library, Fuqua School of Business (library.fuqua.duke.edu)
- Goodson Law Library (law.duke.edu/lib)
- Medical Center Library (mclibrary.duke.edu)

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)

Student Disability Access Office (SDAO)

The Student Disability Access Office (SDAO) recognizes disability as an aspect of diversity that is integral to society and to our campus community. Accessibility is an essential feature of the Duke campus, and we strive to create an inclusive community for our students. We strive to ensure that students with disabilities are provided the tools they need to fully access all aspects of student life inside and outside of the classroom.

Core Functions of SDAO

- Partner with students with disabilities to establish services for their access and inclusion on campus
- Manage, coordinate, implement and evaluate accommodation/service programs
- Serve as a resource to students/faculty/staff to ensure effective provision of services
- Provide educational and resource support to the campus community to increase awareness regarding how to create and sustain access and inclusion for students with disabilities in all aspects of the university
- Provide resource and referral information to the campus community and prospective student and their families

SDAO works with each student individually to establish academic adjustments and auxiliary aids and services, more frequently referred to as academic accommodations for the purpose of eliminating the environmental barriers impacting the student's equitable access to the campus facilities, programs and activities. To find out more information about how to establish services with SDAO you can contact us in the following ways.

In order to receive consideration for reasonable accommodations under Section 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act of 1990 (ADA), and the ADA Amendments Act of 2008, a student must have a physical or mental impairment that substantially limits one or more major life activities. Students requesting accommodations under the provisions of the ADA, ADA Amendments Act of 2008, and Section 504 of the Rehabilitation Act of 1973 (e.g., academic, accessibility, housing) must contact the Student Disability Access Office to explore possible coverage. Students with medical conditions not covered under the provisions of the ADA and the ADA Amendments Act may wish to contact Duke Student Health Service. Additional information and requests for accommodations may be found on the SDAO website.

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

Housing, Dining, & Transportation

Housing and Residence Life (HRL)

Undergraduate Housing. Housing, Dining and Residence Life manages all aspects of the university's three-year undergraduate residency requirement. Residential programs are designed to build positive communities that value learning, create new opportunities for faculty engagement, and generate positive social connections. HRL, student residents and others in the Duke community develop and maintain environments that support classroom learning and encourage students to seek learning opportunities in the world around them. HRL promotes opportunities for students to connect with others and develop a strong and enduring sense of belonging; and intentionally provide opportunities for students to grow and develop as they continue to negotiate developmental issues related to identity, autonomy, and responsibility. HRL programs are rooted in the concepts of mutual respect and civility, and recognize and celebrate the dignity and self-worth of all members. For more information, visit studentaffairs.duke.edu/hdrl.

Graduate and Professional Student Apartments. Limited on-campus housing is available to full-time graduate students. For more information on graduate student housing application timeline and facility amenities, visit students.duke.edu/living/housing/graduate-professional-housing. Assignments are made in the order of receipt of completed applications.

Off-Campus Housing. The Duke Community Housing Office maintains a listing of rental apartments, rooms, and houses provided by property owners or real estate agencies in Durham at durhamgradhousing.com.

Duke Housing and Residence Life (HRL) operates a website specifically to simplify the off-campus housing search for students, parents, faculty and staff, and for area property owners and managers at nearduke.com/housing.

Duke Dining. Duke is home to one of the most innovative, dynamic, and cutting edge collegiate dining programs in the country, with access to over 50 dining locations that include 33 on-campus locations, Merchants-on-Points (off-campus restaurants that deliver), and food trucks. Find more information at students.duke.edu/living/dining.

DukeCard

All Duke students are issued electronic Duke University identification cards through their mobile devices. This identification should be carried at all times. DukeCards are the means of identification for library privileges, athletic events, and other university functions or services open to them as university students. Students will be expected to present their cards on request to any university official or employee. DukeCards are not transferable and fraudulent use may result in loss of student privileges or suspension. For more information, visit dukecard.duke.edu.

Parking & Transportation

Duke Parking & Transportation provides the Duke community with parking options that balance price and convenience while managing supply and demand across the parking system. A valid permit is required in all locations; most locations are gated and the permit activates the entry and exit gates. Visitors who do not have a permit pay by the hour in facilities specially set aside for them. Accommodations are also available for patrons that require accessible parking or transportation.

Options include annual permits and short-term permits that allow for flexible or occasional parking. Anyone affiliated with Duke is eligible to purchase on-campus parking in available locations. There are also many transportation options available at Duke, including Duke Transit (buses), vans, city and regional buses, private taxi service, and a ride-hailing program. For more information, visit parking.duke.edu.

Student Affairs & Organizations

The Division of Student Affairs is critically engaged in supporting the holistic engagement and personal growth of all students who attend Duke. The Division collaborates with student leaders, faculty, families, community members and many others in the delivery of key services.

Its programs and services are designed to support holistic wellbeing, foster an inclusive and dynamic community, and complement Duke's commitment to academic excellence. For more information, visit studentaffairs.duke.edu.

The Student Affairs Identity and Cultural Centers also serve as important resources and places of connection and support for many of our students. The centers are offering programming and support throughout the year, including summer. ICCs include:

- Center for Multicultural Affairs
- Center for Muslim Life
- Center for Sexual and Gender Diversity
- Duke International Student Center

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- Jewish Life at Duke
- Mary Lou Williams Center for Black Culture
- Women's Center

Graduate and Professional Student Government

The Graduate and Professional Student Government of Duke University (GPSG) is the umbrella student government organization for Duke's nine graduate and professional schools. Its purpose is to: represent and advocate on behalf of graduate and professional students at Duke University; serve as a liaison among the student governments of the graduate and professional schools of the University; serve as a liaison between graduate and professional students and the University Administration; nominate graduate and professional student representatives to University committees; program events of interest to the graduate and professional student community; and financially support the programming of graduate and professional student groups.

Visit the GPSG website at gpsg.duke.edu. Contact GPSG (gpsgexec@duke.edu) for additional details on how students can become involved.

The Black Graduate and Professional Student Association

The Black Graduate and Professional Student Association (BGPSA) represents all minority graduate and professional students on the Duke University campus. The association's primary mission is to enhance the Duke experience for its members through community service, social, and academically based programming events. As an umbrella organization, the association welcomes students from groups including the Black & Latino MBA Organization, Black Law Students Association, Black Seminarists Union, Bouchet Society, Hurston-James Society, and Student National Medical Association. Through its academic forums, luncheons, community service initiatives, social events, and recognition ceremony the group hopes to assist in the development of future minority leadership in the Duke community and in the world.

Religious Life

In partnership with the Division of Student Affairs, the Chapel convenes, supports, and advocates for all of the officially recognized Religious Life groups on campus that serve students, including Buddhist, Catholic, Hindu, Jewish, Latter-Day Saints, Muslim, Orthodox, and Protestant organizations and groups. There are about two dozen Religious Life groups at Duke; find a listing of them at chapel.duke.edu/religiouslife.

With a mission of "bridging faith and learning," the Chapel holds ceremonies, concerts, Christian worship services, and more. It is a sanctuary open to all people for important personal moments of prayer, reflection, grief, and gratitude. The Chapel's Student Ministries provides opportunities for undergraduate students to hear and respond to God's call for their lives on campus, in Durham, and beyond through study, artistic expression, counsel, service, and community. Learn more at chapel.duke.edu.

Intercollegiate Athletics

The Athletic Department fosters intercollegiate athletics by striving for excellence and by providing the best possible framework within which highly accomplished student-athletes can compete. The department has a dual responsibility to provide a high-quality athletic program and environment so that all students have the opportunity to compete to the fullest extent of their abilities. Duke is a member of the National Collegiate Athletic Association (NCAA) and the Atlantic Coast Conference (ACC).

Student Health & Safety

Campus Police

It is the mission of the Duke University Police Department to protect and serve the people and property of Duke. We are guardians of a community of world class education, research and healthcare and must prevent violence, reduce fear, and build relationships. For more information, visit police.duke.edu.

Counseling & Psychological Services (CAPS)

CAPS helps Duke students enhance their strengths and learn to cope with the trials of living, growing, and learning. CAPS offers many services to Duke undergraduate, graduate, and professional students, including brief individual counseling/psychotherapy, consultation, couples and group counseling, and assistance with referrals. CAPS' staff also provide outreach education programs to student communities, promoting an empathic and supportive culture. Staff members are available for consultation with faculty

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concerning students or other matters relating to mental health in the university community. The CAPS staff includes psychologists, clinical social workers, and psychiatrists experienced in working with college-age adults. CAPS' staff carefully adhere to professional standards of ethics, privacy, and confidentiality. For more information, visit studentaffairs.duke.edu/caps.

DukeReach

DukeReach provides direct case management services including interventions, advocacy, referrals and follow-up services for students who are experiencing significant difficulties related to mental health, physical health, and/or psycho-social adjustment. The Assistant and Associate Deans in DukeReach coordinate student services and provide connections with campus departments as well as outside agencies and providers. For more information, visit studentaffairs.duke.edu/dukereach.

DuWell

DuWell works to enhance the educational experience for Duke students by addressing substance use and abuse issues and promoting healthy physical, emotional and social development, including issues related to sexual health. It offers one-on-one screening (for substance use) and health coaching, workshops and trainings on the different topic areas of wellness (including Social Host Education, Stress and Sexual Health workshops) and programs for student groups upon request. Consultation on prevention of high-risk behavior and promotion of wellness is available to students, faculty, professionals and staff. DuWell is dedicated to fostering a living/learning environment on campus and within the surrounding community that encourages the full development of the individual as an engaged member of the community. For more information, visit studentaffairs.duke.edu/duwell.

Student Health

Student Health Services at Duke University is jointly supported by the Division of Student Affairs and the Department of Pediatrics. The Duke Student Health Center is the primary source for a wide range of healthcare services, many of which are covered by the Student Health Fee. Its mission is to provide evidence-based, patient-centered health care to the Duke student community in a professional and compassionate manner that directly contributes to the student's well-being and overall success. For more information, visit 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 2023
<p>February February 20 (M) Registration begins for all summer sessions</p>
<p>May May 17 (W) Term 1 classes begin (Monday class meeting schedule is in effect on this day) May 18 (Th) Regular class meeting schedule begins. Thursday class schedule is followed May 19 (F) Drop/Add for Term 1 ends May 29 (M) Memorial Day holiday. No classes</p>
<p>June June 19 (M) Juneteenth holiday. No classes June 26 (M) Term 1 classes end June 27 (Tu) Reading period June 28-29 (W-Th) Final exams</p>
<p>July July 3 (M) Term 2 classes begin July 4 (M) Independence Day holiday. No classes July 6 (Th) Drop/Add for Term 2 ends</p>
<p>August August 10 (Th) Term 2 classes end August 11 (F) Reading period August 13 (Su) Final exams</p>
FALL 2023
<p>August August 22 (Tu) New graduate student orientation begins August 23 (W) Welcome reception for new graduate and professional students August 28 (M) Fall semester classes begin</p>
<p>September September 4 (M) Labor Day. No classes September 8 (F) Drop/Add ends for fall September 28-October 1 (Th-Su) Founders' Weekend</p>
<p>October October 14-17 (Sa-Tu) Fall break October 23 (M) Shopping carts open for Spring 2024</p>
<p>November November 1 (W) Registration begins for Spring 2024 November 22-26 (W-Su) Thanksgiving recess</p>
<p>December December 1 (F) Graduate classes end December 18 (M) Final exams end</p>
SPRING 2024
<p>January January 10 (W) Spring semester classes begin (Monday class meeting schedule is in effect on this day) January 15 (M) Martin Luther King, Jr. Day holiday. No classes January 24 (W) Drop/Add ends for spring</p>
<p>February February 19 (M) Registration begins for Summer 2024</p>
<p>March March 9-17 (Sa-Su) Spring recess March 25 (M) Shopping carts open for Fall 2024</p>

SUMMER 2023
April April 3 (W) Registration begins for Fall 2024 April 17 (W) Graduate classes end
May May 4 (Sa) Final exams end May 10 (F) Commencement begins; MEM Online Hooding Ceremony May 11 (Sa) MEM Hooding Ceremony; MEng Hooding Ceremonies May 12 (Su) Graduation exercises; conferring of degrees
SUMMER 2024
February February 19 (M) Registration begins for Summer 2024
May May 15 (W) Term 1 classes begin May 17 (F) Drop/Add for Term 1 ends May 27 (M) Memorial Day holiday. No classes
June June 19 (W) Juneteenth holiday. No classes June 24 (M) Term 1 classes end June 25 (Tu) Reading period June 26-27 (W-Th) Final exams
July July 1 (M) Term 2 classes begin July 3 (W) Drop/Add for Term 2 ends July 4 (Th) Independence Day holiday. No classes
August August 8 (Th) Term 2 classes end August 9 (F) Reading period August 9-11 (F-Su) Final exams

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

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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.

Jurisdiction

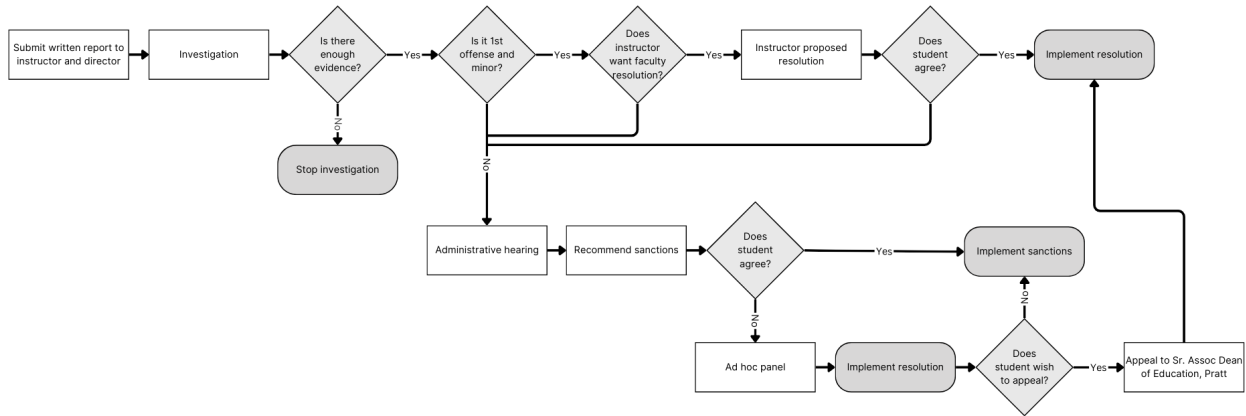
- Program leaders may respond to any complaint of behavior that occurred within a student's involvement in the academic program, from application to graduation. However, complaints of discrimination, harassment (including sexual harassment which, in turn, includes sexual violence and other forms of sexual 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 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

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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 nontolerance 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

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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.

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For matters that do not involve suspension or expulsion from the university, the appeal process for the outcome of an administrative hearing is to the associate dean for research and infrastructure.

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:

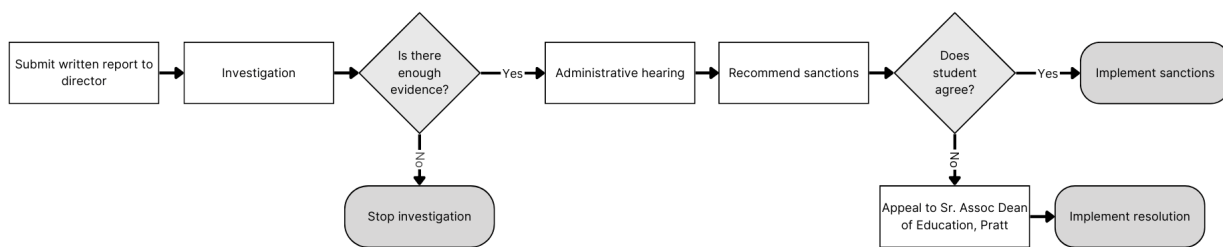
- to be informed that the student is under investigation;
- to seek advice from anyone;
- to be given an opportunity to respond to allegations;
- to choose the extent to which the student shares information (false or misleading information will be viewed as lying);
- to be notified of a hearing at least 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 to the associate dean for research and infrastructure. 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 appeal the decision to the associate dean for research and infrastructure. 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

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- 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.

Administration

Pratt Administration

Jerome Lynch, PhD, F.EMI, Dean

Judge Carr, Senior Associate Dean for Development and Alumni Affairs

Ashutosh Chilkoti, PhD, Senior Associate Dean

Joel Collier, PhD, Associate Dean for Doctoral Education

Rebecca Dupre, Associate Dean for Finance and Administration

Bradley A. Fox, PhD, Associate Dean for Master's Education

Aaron Franklin, PhD, Associate Dean for Faculty Affairs

Linda Franzoni, PhD, Associate Dean for Undergraduate Education

Sharon Gerecht, PhD, Associate Dean for Research and Infrastructure

Jim Ruth, Associate Dean and Director of Development and Alumni Affairs

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

Joseph Izatt, PhD, Chair, Department of Biomedical Engineering

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

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

Catherine Brinson, 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.](#)

Student Resources

Career Services

The Duke Engineering Master's Career Services team and the Duke Career Center offer a wide range of outstanding career support to all engineering master's students. The aim of Career Services is to help students realize their professional goals while transitioning from Duke into the workplace. Services offered to students include career coaching, content and tools to support student job searches, events for instruction and employer connection, and proactive communication. For more information, visit careerhub.students.duke.edu/channels/engineering-masters.

Graduate Communications and Intercultural Programs (GCIP)

GCIP is a comprehensive communications and intercultural resource and support center for all engineering graduate students. Serving international and domestic students, GCIP offers individual and small-group coaching by appointment. GCIP also organizes workshops and semester-long courses. To make an appointment with a consultant or learn about other services, visit the GCIP website at pratt.duke.edu/grad/students/comms-intercultural-programs.

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 Master's Programs Student Clubs, and Engineering Graduate Student Council, 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-masters-studentservices@duke.edu.

Student Engagement and Support

The Duke Engineering Master's Student Engagement and Support (SES) team provides community building and support opportunities to all engineering master's students. The SES team oversees the Engineering Master's Student Advisory Board and Engineering Master's Student Clubs, and supports students individually with a variety of personal needs. From onboarding and new student orientation through graduation, the SES encourages students to get involved in the engineering master's experience. The SES team also has a broad set of supports and resources available to assist students with a variety of personal and professional needs. To contact SES, email pratt-masters-studentservices@duke.edu.

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 (MEM only)

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 2023-2024 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 in rounds, 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

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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.

Duke University MEM & MEng Tuition & Fees

Tuition for the 2023-2024 academic year is \$32,167.50 (MEM) or \$31,762.50 (MEng) per semester. In general, completion of the eight required program courses would result in a total tuition cost of \$64,335 for MEM students. For MEng students, completion of the 30.0 required credits over three semesters would result in a total tuition cost of \$95,287.50.

Part-time MEM campus students and students in standalone graduate certificate programs pay \$2,680.63 by course unit. Part-time MEng campus students pay \$3,176.25 by course unit.

Estimated Full-Time Student Expenses for the 2023-2024 Academic Year

	MEM ON-CAMPUS STUDENTS	MEM ONLINE STUDENTS	MENG ON-CAMPUS STUDENTS
Tuition	\$64,335 (\$32,167.50/semester)	\$64,335 (\$16,083.75/semester)	\$63,525 (\$31,762.50/semester)
Health Fee	\$936*	-	\$936*
Health Insurance	\$3,510**	-	\$3,510**
Graduate Student Activity Fee	\$37	-	\$37
Graduate and Professional Student Services	\$24	-	\$24
Transcript Fee (one-time fee)	\$120*	\$120*	\$120*
Recreation Fee	\$358	-	\$358
Room	\$13,032*	\$4,035 (\$1,345 residency)	\$13,032*
Board	\$4,086*	-	\$4,086*
Books	\$610*	\$610*	\$610*
Transportation and Miscellaneous	\$6,084*	-	\$6,084*
Total	\$93,132	\$69,100	\$92,322

*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.

MEM-Specific Information

- The normal program duration is one year of study (two semesters).
- The normal load is four courses (12.0 units) per semester.
- Duke MEM Online tuition for the 2023-2024 academic year is \$8,041.88 per course taken at the university. Students generally take two courses per semester over four semesters. Details for tuition, fees, and estimated expenses can be found at memp.pratt.duke.edu/online/tuition-financial-aid.
- No tuition is charged for the internship course, internship assessment course, or seminar series.
- There is no charge for registration for students in the Master of Engineering Management Program. Domestic students can estimate \$455 in loan fees per semester if securing student loans.

MEng-Specific Information

- The normal program duration is one and one-half years of study (three semesters).
- The normal load is four courses (12.0 units) per semester in the first year.
- There is no charge for registration for students in the Master of Engineering Program. Domestic students can estimate \$455 in loan fees per term if securing student loans.
- Artificial Intelligence for Product Innovation students can find details for tuition, fees, and estimated expenses at ai.meng.duke.edu/degree#more-details.
- Online MEng students can find details for tuition, fees, and estimated expenses at meng.pratt.duke.edu/apply/tuition-financial-aid.

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 transcript of academic records or 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 on 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 fees. Residential students who continue into a fourth semester will be charged tuition at a per-unit rate, including all student fees.

MEM Online students. Students enrolling in the MEM Online Program will be set up for pay-per-semester billing at the start of each semester; however, they will 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.

Part-time students. Students enrolling part-time will automatically be set up for payments on a per-unit basis. If an enrolling student intends to take less than the typical load (four courses for full-time, two courses for MEM Online), contact the student records coordinator to make this change. The last day for making changes to a student's billing structure is the last day of Drop/Add in that semester. Part-time campus students pay \$2,680.63 by course unit throughout the program.

Students should contact the student records coordinator to alter their payment structure after the start of the program. Students must pay at least the full tuition amount for the program. For example, a student may not take five courses in term one on a semester-based plan and then take three courses in the following term on a per-unit basis.

MEng-Specific Tuition Policies

Tuition is charged on a per-semester basis. Students who decide to complete the MEng Program in four semesters will be changed to part-time students in their fourth semester, and tuition will then be charged on a per-unit basis. These fourth semester students do not have to be enrolled in a full course load but must be enrolled in at least one unit. Students enrolling as part-time for the duration of the program may request tuition payment on a per-unit basis. Students enrolling as full-time may not request payment on a per-unit basis until the fourth semester, as stated above.

Tuition & Fees

Duke Kunshan University Tuition & Fees

Program tuition for the 2023-2024 academic year is \$31,762.50 for international students and ¥90,000 for PRC students per semester taken at Duke Kunshan University. It is \$31,762.50 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 2023-2024 Academic Year

	INTERNATIONAL STUDENTS	PRC STUDENTS
Tuition	\$63,525 (\$31,762.50/semester)	¥180,000 (¥90,000/semester)
Health Insurance	\$1,434	¥800
Books & Supplies	\$632	¥4,392
Residence	\$3,454	¥24,000
Board	\$2,719	¥18,900
Domestic/International Travel	\$3,000	¥2,000
Transportation and Misc.	\$1,727	¥12,000
Total	\$76,491	¥242,072

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.

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- 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 12,000 RMB/1,727 USD or 10,000RMB/1,438 USD per semester, the double room is 8250 RMB/1,187 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.
- All students must pay a refundable Campus Deposit of 2,000 RMB/300 USD. The deposit would be used to pay for the costs of replacement or repairs of losses and damages caused to university properties and some miscellaneous charges such as residence damages, excessive cleaning, refrigerator rental, library overdue fines, damaged or lost books, replacement processing fees, etc.
- 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).

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 with an emphasis on increasing diversity within the program.

The MEM Program has limited financial assistance available through the following scholarships:

- scholarships for underrepresented students
- Wilkinson and Garda Scholarships for Outstanding Students

See memp.pratt.duke.edu/campus/tuition-financial-aid for more information about scholarships.

DoD SMART Scholarship Program (US Citizens Only)

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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

Computational Mechanics and Scientific Computing

Cybersecurity (also offered online)

Electrical and Computer Engineering (also offered through Duke Kunshan University)

Environmental Engineering

Financial Technology (also offered online)

Materials Science and Engineering

Mechanical Engineering

Medical Technology Design

Photonics and Optical Sciences

Risk Engineering

Master of Engineering Management (also offered online)

Certificates

Concurrent Graduate Certificates

Aerospace

AI for Materials (aiM)

Biomedical Data Science

Biotechnology

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

Master of Engineering

Program Summary

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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
- Computational Mechanics and Scientific Computing
- Cybersecurity (also offered online)
- Electrical and Computer Engineering (also offered through Duke Kunshan University)
- Environmental Engineering
- Financial Technology (also offered online)
- Materials Science and Engineering
- Mechanical Engineering
- Medical Technology Design
- Photonics and Optical Sciences
- Risk Engineering

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 the 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.

Master of Engineering (E-EGR)

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 courses taken for audit and courses with grades of (Z) Continuing or (N)o grade given.

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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 the master's program. Any suspension, dismissal, or graduation decision made by the associate dean of the master's program may be appealed within seven days to the Associate Dean for Research and Infrastructure.

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 MEng Program Admissions Committee, and appeals will be heard by the Associate Dean for Research and Infrastructure.

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 in writing to the associate dean of research and infrastructure.

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

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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/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.

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 transfer up to 4 courses into the MEng 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:

- a maximum of 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

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To be considered a full-time student, students must be registered for at least 9.0 course credits. Enrolling in fewer than 9.0 course 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. All students in their final semester must register for at least 1.0 tuition-bearing credit.

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)
 - Master of Engineering 570 (Business Fundamentals for Engineers)
 - Master of Engineering 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
 - Master of Engineering 550 (Master of Engineering Internship/Project)
 - Master of Engineering 551 (Master of Engineering Internship/Project Assessment)

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 (Master of Engineering 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.

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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 two 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

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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 to the Associate Dean for Research and Infrastructure. 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 into Pratt's Professional Master's Programs from The Graduate School (MS/PhD to MEM or MEng)

Students may transfer into professional master's programs offered by the Pratt School of Engineering from The Graduate School with the approval of The Graduate School, the original program, and the new program. Students desiring a transfer must submit the following materials to the Professional Master's Programs office:

- a signed Pratt School of Engineering's Professional Master's Transfer Form; and
- an Apply Yourself application (application fee is waived).

Students may be able to transfer some Graduate School application documents to the Pratt School of Engineering. To request the release of these documents, please submit the Authorization and Consent to Release of Educational Record Form to The Graduate School. If original letters of recommendation are not available, the student may request Letters of Recommendation from their current program.

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Generally, if a student is leaving the MS or PhD degree and will not earn the full degree, the credits will transfer with grades that will count toward the professional master's program grade point average.

Transferring within Pratt's Professional Master's Programs (MEM to MEng or MEng to MEM)

Students may transfer between professional master's programs offered by the Pratt School of Engineering with the approval of the original program and the new program. If the transfer is approved, students must submit a signed Pratt School of Engineering Professional Master's Transfer Form to the student records coordinator for processing.

Transferring from Pratt's Professional Master's Programs to The Graduate School (MEM or MEng to MS/PhD)

Students transferring from professional master's programs offered by the Pratt School of Engineering to The Graduate School should follow The Graduate School's application process (gradschool.duke.edu/admissions). If transcripts, letters of recommendation, or other application information need to be forwarded to The Graduate School, please fill out the Authorization and Consent to Release of Educational Record Form and submit it to the Professional Master's Programs office.

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

Students who exhibit harmful, potentially harmful, or disruptive behavior toward themselves or others may be subject to involuntary administrative withdrawal from the university if their behavior renders them unable to effectively function in the university community. Such behavior includes, but is not limited to, that which

- poses a significant threat of danger and/or harm to self and/or other members of the university community; and/or
- interferes with the lawful activities or basic rights of other students, university employees, or visitors.

Any member of the university community who has reason to believe that a student may meet the standard for an involuntary administrative withdrawal may contact the vice president for Student Affairs or their designee. The vice president or designee will conduct a preliminary review in consultation with professionals from Student Health and/or Counseling and Psychological Services, the associate dean of master's program, and/or other relevant individuals. The vice president or designee will meet, when possible, with the student in question to discuss the information that has been presented and give the student an opportunity to respond. The vice president or designee may mandate that the student be evaluated by a specified health professional within a given time frame if an evaluation has not already been conducted. In the instances described above the vice president for Student Affairs or designee will make the final decision about involuntary administrative withdrawal. A written statement citing the reasons will be forwarded to the associate dean of master's program, who will withdraw the student from the university. At any point in the process, the student may request a voluntary withdrawal via the associate dean of master's program.

Master of Engineering (E-EGR)

Master of Engineering in Artificial Intelligence for Product Innovation

Program Code: E-EGR-AIPI

Degree Designation: Master of Engineering

Duke University

Department: Engineering Management Program

Website: ai.meng.duke.edu/degree

Program Summary

Students in the MEng Artificial Intelligence for Product Innovation On-Campus Program develop strong technical skills together with an understanding of product design. After graduation, students are well-equipped to design and develop AI-based products and systems within large companies or through their 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.

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);
- A minimum of one (1) semester of programming (any language);
- 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

Fulfill all of the following requirements:

- Must maintain a program GPA of at least 2.999.
- Count courses only from the given course set: Course with an enrollment tag EGRP.
- Course substitutions may be approved at the program director's discretion.

Change to Degree Requirements Beginning Fall 2023

Students admitted prior to the Fall 2023 term are required to complete **AIPI 530 - Optimization (3 units)** or **AIPI 531 - Deep Learning Reinforcement Applications (3 units)** and **two Technical Electives** as part of their degree requirements.

Students admitted from Fall 2023 onward are **no longer required to complete AIPI 530 or AIPI 531**. Instead, they must complete **one AIPI Departmental Elective** and **two Technical Electives**.

Students admitted prior to the Fall 2023 term may request to take an AIPI Departmental Elective instead of AIPI 530 or AIPI 531 at the program director's discretion.

Pre-Program Bootcamp

Fulfill all of the following requirements:

- AIPI 503 Python Bootcamp (0 units)

Career Strategy & Design Course

On-campus students admitted for the Fall 2023 term and later must fulfill all of the following requirements:

- EGR 590 Special Topics: Career Strategy and Design (1 non-tuition-bearing unit)

Core Industry Preparatory Courses

Fulfill all of the following requirements:

Duke University

- MENG 540 Management of High Tech Industries (3 units)
- MENG 570 Business Fundamentals for Engineers (3 units)

Internship/Project & Assessment

Fulfill all of the following requirements:

- MENG 550 Master of Engineering Internship/Project (0 units)
- MENG 551 Master of Engineering Internship/Project Assessment (0 units)

Technical Core

Fulfill all of the following requirements:

AIPI 510 and AIPI 520

Fulfill all of the following requirements:

- AIPI 510 Sourcing Data for Analytics (3 units)
- AIPI 520 Modeling Process and Algorithms (3 units)

Students who have completed prior courses covering the topics in AIPI 510 and/or AIPI 520 may apply for a waiver of these requirement(s). If a student receives a waiver for one or both of these courses, they are required to take additional elective credits in place of the course(s) waived.

AIPI 530 or AIPI 531

Students admitted prior to the Fall 2023 term must fulfill one of the following requirements:

- AIPI 530 Optimization in Practice (3 units)
- AIPI 531 Deep Reinforcement Learning Applications (3 units)

Students admitted from Fall 2023 onward are not required to complete AIPI 530 or 531, but can use AIPI 530 or AIPI 531 to fulfill their AIPI Departmental Elective requirement.

AIPI 540 Deep Learning Applications (3 units)

AIPI 510 to AIPI 590L AIPI Departmental Elective (3 units)

AI Operations Core

Fulfill all of the following requirements:

- AIPI 501 AIPI Seminar (0 units)
- AIPI 560 Legal, Societal, and Ethical Implications of AI (1.5 units)
- AIPI 561 Operationalizing AI (1.5 units)

Industry Project

Fulfill all of the following requirements;

- AIPI 549 Industry Project Practicum 1 (3 units)

Technical Electives

Take at least 6 credits that match the following:

- AIPI 510 to AIPI 590L
- BME 500 to BME 850
- CEE 500 to CEE 890
- CYBERSEC 510 to CYBERSEC 590L
- ECE 500 to ECE 781
- EGRMGMT 510 to EGRMGMT 590L
- FINTECH 510 to FINTECH 590L
- ME 500 to ME 775

Master of Engineering in Artificial Intelligence for Product Innovation—Online

Program Code: E-EGR-AIPO

Degree Designation: Master of Engineering

Department: Engineering Management Program

Website: ai.meng.duke.edu/degree

Program Summary

Students in the MEng Artificial Intelligence for Product Innovation Online Program develop strong technical skills together with an understanding of product design. After graduation, students are well-equipped to design and develop AI-based products and systems within large companies or through their 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.

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);
- A minimum of one (1) semester of programming (any language);
- 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

Fulfill all of the following requirements:

- Must maintain a program GPA of at least 2.999
- Count courses only from the given course set: Course with an enrollment tag EGRP.
- Course substitutions may be approved at the program director's discretion.

Change to Degree Requirements Beginning Fall 2023

Students admitted prior to the Fall 2023 term are required to complete **AIPI 530 - Optimization** or **AIPI 531 - Deep Learning Reinforcement Applications** and **two Technical Electives** to fulfill their degree requirements.

Students admitted from Fall 2023 onward are **no longer required to complete AIPI 530 or AIPI 531**. Instead, they must complete **one AIPI Departmental Elective** and **two Technical Electives**.

Students admitted prior to the Fall 2023 term may request to take an AIPI Departmental Elective instead of AIPI 530 or AIPI 531 at the program director's discretion.

Pre-Program Bootcamp

Fulfill all of the following requirements:

- AIPI 503 Python Bootcamp (0 units)

Core Industry Preparatory Courses

Duke University

Fulfill all of the following requirements

- MENG 540 Management of High Tech Industries (3 units)
- MENG 570 Business Fundamentals for Engineers (3 units)

Internship/Project & Assessment

Fulfill all of the following requirements:

- MENG 550 Master of Engineering Internship/Project (0 units)
- MENG 551 Master of Engineering Internship/Project Assessment (0 units)

Technical Core

Fulfill all of the following requirements:

AIPI 510 and AIPI 520

Fulfill all of the following requirements:

- AIPI 510 Sourcing Data for Analytics (3 units)
- AIPI 520 Modeling Process and Algorithms (3 units)

Students who have completed prior courses covering the topics in AIPI 510 and/or AIPI 520 may apply for a waiver of these requirement(s). If a student receives a waiver for one or both of these courses, they are required to take additional elective credits in place of the course(s) waived.

AIPI 530 or AIPI 531

Students admitted prior to the Fall 2023 term must fulfill one of the following requirements:

- AIPI 530 Optimization in Practice (3 units)
- AIPI 531 Deep Reinforcement Learning Applications (3 units)

Students admitted from Fall 2023 onward are not required to complete AIPI 530 or 531, but can use AIPI 530 or AIPI 531 to fulfill their AIPI Departmental Elective requirement.

- **AIPI 540 Deep Learning Applications (3 units)**
- **AIPI 510 to AIPI 590L AIPI Departmental Elective (3 units)**

AI Operations Core

Fulfill all of the following requirements:

- AIPI 501 AIPI Seminar (0 units)
- AIPI 560 Legal, Societal, and Ethical Implications of AI (1.5 units)
- AIPI 561 Operationalizing AI (1.5 units)

Industry Project

Fulfill all of the following requirements:

- AIPI 549 Industry Project Practicum 1 (3 units)

Residency

Fulfill all of the following requirements:

- AIPI 504 Introductory Residency (0 units)
- AIPI 505 Mid-Program Residency (0 units)

Technical Electives

Take at least 6 credits that match the following:

- AIPI 510 to AIPI 590L
- BME 500 to BME 850
- CEE 500 to CEE 890
- CYBERSEC 510 to CYBERSEC 590L
- ECE 500 to ECE 781

Duke University

- EGRMGMT 510 to EGRMGMT 590L
- FINTECH 510 to FINTECH 590L
- ME 500 to ME 775

Master of Engineering (E-EGR)

Master of Engineering in Biomedical Engineering

Program Code: E-EGR-BME

Degree Designation: Master of Engineering

Department: Engineering Management Program

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

Academic Requirements

- Fulfill all of the following requirements
- Must maintain Program GPA of at least 2.999

Core Industry Preparatory Courses

Fulfill all of the following requirements

- MENG 540 Management of High Tech Industries
- MENG 570 Business Fundamentals for Engineers or BME 590 with the topic Business in BME

Internship/Project and Assessment

Fulfill all of the following requirements

- MENG 550 Master of Engineering Internship/Project
- MENG 551 Master of Engineering Internship/Project Assessment

Departmental Requirements

Fulfill all of the following requirements

Advanced Mathematics Course Take at least 3 credits that match the following:

- BME 671L CBB 540 CEE 530 CEE 630 COMPSCI 520 MATH 541 MATH 545 MATH 551 MATH 561 MATH 563 MATH 565 MATH 577 MATH 660 MATH 721 MATH 753 ME 524 PHYSICS 760 STA 601 STA 601L STA 611 STA 621
- BME 790L with one of these topics: COMP LINEAR ALGEBRA IN BME; SIGNAL PROC & APP MATHEMATI; SIGNAL PROC & APP MATHEMATICS

Life Science Course Take at least 3 credits that match the following:

- BIOCHEM 536 BIOCHEM 622 BIOCHEM 681 CBB 520 CELLBIO 730 CELLBIO 761 CELLBIO 762 CELLBIO 763 CMB 797 EVANTH 530 IMMUNOL 544 IMMUNOL 800 MEDPHY 505 MGM 701 MGM 732 NEUROBIO 719 NEUROBIO 720 NEUROBIO 759S NEUROBIO 760S
- BME 790L with the topic QUANTITATIVE PATHOPHYSIOLOGY
- BME 790 with one of these topics: PHYSIOLOGY FOR ENGINEERS; QUANTITATIVE PATHOPHYSIOLOGY

BME Technical Course Take at least 9 credits that match the following:

- BME 500 to BME 888
- Following courses do not count: BME 791 BME 792 BME 899

Electives

Take at least 9 credits that match the following:

- BIOCHEM 536 BIOCHEM 622 BIOCHEM 681 BIOCHEM 761 BIOCHEM 762 BIOCHEM 763 CBB 520 CBB 540 CBB 622 CBB 726 CELLBIO 503 CELLBIO 730 CELLBIO 761 CELLBIO 762 CELLBIO 763 CMB 797 COMPSCI 520 COMPSCI 527 EVANTH 530 EVANTH 538S HLTHMGMT 711 HLTHMGMT 712 I&E 720 I&E 721 I&E 835 IMMUNOL 544 IMMUNOL 800 INCH_BME 890 MATH 541 MATH 545 MATH 551 MATH 561 MATH 563 MATH 565 MATH 577 MATH 660 MATH 753 MEDPHY 505 MEDPHY 530 MEDPHY 734 MGM 701 MGM 732 MOLCAN 761 MOLCAN 762 MOLCAN 763 NEUROBIO 719 NEUROBIO 720 NEUROBIO 759S NEUROBIO 760S PHARM 533 PHARM 534 PHARM 835 PHYSICS 760 STA 601 STA 601L STA 611 STA 621 UPGEN 732S
- AIP1 510 to AIP1 590L
- BME 500 to BME 850
- CEE 500 to CEE 890
- CYBERSEC 510 to CYBERSEC 590L
- ECE 500 to ECE 781
- EGRMGMT 510 to EGRMGMT 590L
- FINTECH 510 to FINTECH 590L
- ME 500 to ME 775
- I&E 590 with the topic HACKING FOR DEFENSE
- I&E 790 with the topic BIODESIGN: IMPLEMENT

Master of Engineering (E-EGR)

Master of Engineering in Civil Engineering

Program Code: E-EGR-CE

Degree Designation: Master of Engineering

Department: Engineering Management Program

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.

Academic Requirements

- Fulfill all of the following requirements
- Must maintain Program GPA of at least 2.999

Core Industry Preparatory Courses

Fulfill all of the following requirements:

- MENG 540 Management of High Tech Industries
- MENG 570 Business Fundamentals for Engineers

Internship/Project and Assessment

Fulfill all of the following requirements:

- MENG 550 Master of Engineering Internship/Project
- MENG 551 Master of Engineering Internship/Project Assessment

Seminar

Fulfill any of the following requirements:

- CEE 701 Graduate Colloquium
- CEE 702 Graduate Colloquium

Concentration Requirements

Fulfill any of the following requirements:

Duke University

Computational Engineering Take at least 6 credits that match the following:

- CEE 621 CEE 630 CEE 635 COMPSCI 520 COMPSCI 532 MATH 563 MATH 661 MATH 663 ME 639

Geo-Systems Take at least 6 credits that match the following:

- CEE 525 CEE 621 CEE 630 CEE 641 CEE 642 CEE 644 EOS 540 EOS 575S ME 537 ME 543

Systems Engineering and Optimization Take at least 6 credits that match the following:

- CEE 627 CEE 629 MATH 541 MATH 577
- CEE 690 with one of these topics: NUMERICAL OPTIMIZATION; UNCERTAINTY QUANTIFICATION

Departmental Requirements

Take at least 12 credits that match the following:

- CEE 520 CEE 530 CEE 541 CEE 625 CEE 643 CEE 647 ME 541

Electives

Take at least 6 credits that match the following:

- COMPSCI 520 COMPSCI 532 EOS 540 EOS 575S MATH 541 MATH 551 MATH 561 MATH 563 MATH 577 MATH 661 MATH 663 ME 537 ME 543 ME 639 STA 611
- AIP1 510 to AIP1 590L
- BME 500 to BME 850
- CEE 500 to CEE 890
- CYBERSEC 510 to CYBERSEC 590L
- ECE 500 to ECE 781
- EGRMGMT 510 to EGRMGMT 590L
- FINTECH 510 to FINTECH 590L
- ME 500 to ME 775

Master of Engineering (E-EGR)

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

I. Core Requirements (6 credits / 2 courses)

Duke University

- MENG 540: Management of High Tech Industries (3 credits)
- MENG 570: Business Fundamentals for Engineers (3 credits)

II. Proseminar (0 credits / 1 course)

- CE 703 /ME 703: Industrial Colloquia in Computational Mechanics and Scientific Computing

III. Finite Element Methods (6 credits / 2 courses)

- CE 530 / ME 524: Introduction to the Finite Element Method
- CE 630 / ME 525: Nonlinear Finite Element Method

IV. Applied Math/Statistics (3 credits / 1 course from list)

- Math 561: Numerical Linear Algebra
- Math 541: Applied Stochastic Processes
- Math 551: Applied Differential Equations and Complex Variables

V. Computer Science (3 credits / 1 course from list)

- CS 590: Parallel Computing
- ECE 551D: Programming, Data Structures, and Algorithms in C++

VI. Application Areas (4 of any courses from three areas of concentration, 12 credits)

- **Mechanics of Materials**
 - CEE 520: Continuum Mechanics
 - CEE 541: Structural Dynamics
 - ME 555: Computational Materials Science
 - CEE 622: Fracture Mechanics
- **Fluid Mechanics**
 - CEE 531: Finite Element Methods for Problems in Fluid Mechanics
 - ME 572: Engineering Acoustics
 - ME 639: Computational Fluid Mechanics and Heat Transfer
 - CEE 690: Turbulence
- **Optimization / Data Analytics**
 - CS 445/MATH 465: Intro to High Dimensional Data Analysis
 - CE 522/ME 526: Numerical Optimization
 - CS 571D: Machine Learning
 - STA 502: Bayesian Inference and Decision

Other course offerings may be substituted with consent of the Director of Masters Studies.

VII. Internship, Project or Equivalent Requirements (0 credits)

- MENG 550: Internship or Applied Research Project
- MENG 551: Internship/Project Assessment

Master of Engineering (E-EGR)

Master of Engineering in Cybersecurity

Program Code: E-EGR-CYBS

Degree Designation: Master of Engineering

Department: Engineering Management Program

Website: cybersecurity.meng.duke.edu/degree

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.

Duke University

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

- Fulfill all of the following requirements
- Must maintain Program GPA of at least 2.999

Core Industry Preparatory Courses

Fulfill all of the following requirements

- MENG 540 Management of High Tech Industries
- MENG 570 Business Fundamentals for Engineers

Internship/Project and Assessment

Fulfill all of the following requirements

- MENG 550 Master of Engineering Internship/Project
- MENG 551 Master of Engineering Internship/Project Assessment

CYBERSEC 501 Seminar

Technical Core

Take at least 9 credits that match the following:

- CYBERSEC 500 CYBERSEC 502 CYBERSEC 503
- CYBERSEC 590 with the topic CYBERSECURITY RISK MANAGEMENT

Electives

Take at least 15 credits that match the following:

- CYBERSEC 510 CYBERSEC 520 CYBERSEC 521 CYBERSEC 530 CYBERSEC 531 FINTECH 510 FINTECH 564 PUBPOL 551S
- CYBERSEC 590 with the topic WEB3 ENGINEERING & SECURITY

Master of Engineering (E-EGR)

Master of Engineering in Cybersecurity—Online

Program Code: E-EGR-CYBO

Degree Designation: Master of Engineering

Department: Engineering Management Program

Website: cybersecurity.meng.duke.edu/degree

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.

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

- Fulfill all of the following requirements
- Must maintain Program GPA of at least 2.999

Core Industry Preparatory Courses

Fulfill all of the following requirements

- MENG 540 Management of High Tech Industries

Duke University

- MENG 570 Business Fundamentals for Engineers

Internship/Project and Assessment

Fulfill all of the following requirements

- MENG 550 Master of Engineering Internship/Project
- MENG 551 Master of Engineering Internship/Project Assessment

Technical Core

Take at least 9 credits that match the following:

- CYBERSEC 500 CYBERSEC 502 CYBERSEC 503
- CYBERSEC 590 with the topic CYBERSECURITY RISK MANAGEMENT

Residency

Fulfill all of the following requirements

- CYBERSEC 505 Mid-Program Residency

Electives

Take at least 15 credits that match the following:

- CYBERSEC 510 CYBERSEC 520 CYBERSEC 521 CYBERSEC 530 CYBERSEC 531 FINTECH 510 FINTECH 564 PUBPOL 551S
- CYBERSEC 590 with the topic WEB3 ENGINEERING & SECURITY

Master of Engineering (E-EGR)

Master of Engineering in Electrical and Computer Engineering

Program Code: E-EGR-ECE

Degree Designation: Master of Engineering

Department: Engineering Management Program

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, individualized curriculum** oriented around high-demand fields
- **Industry internship** plus professional development support
- **Excellent career outcomes**, and a global alumni network

Academic Requirements

- Must maintain Program GPA of at least 2.999
- Count courses only from the given course set:
 - Course with an enrollment tag EGRP

Core Industry Preparatory Courses

Fulfill all of the following requirements

- MENG 540 Management of High Tech Industries
- MENG 570 Business Fundamentals for Engineers

Internship/Project and Assessment

Fulfill all of the following requirements

- MENG 550 Master of Engineering Internship/Project
- MENG 551 Master of Engineering Internship/Project Assessment

ECE Master's Success Seminar

Fulfill the following requirement

- ECE 701

Concentration Requirements

Fulfill any of the following requirements

Data Analytics and Machine Learning Take at least 9 credits that match the following:

- ECE 551D ECE 580 ECE 581 ECE 582 ECE 586 ECE 587 ECE 588 ECE 682D ME 542 ME 548 STA 601
- ECE 590 with one of these topics: AUTONOMOUS SYSTEMS ENGINEERING; TEXT DATA ACQUISITION ANALYSIS; TEXTUAL DATA ACQ.&ANALYSIS; TXT DATA ACQUISITION ANALYSIS
- ECE 590D with one of these topics: INTRO INTO DEEP LEARNING; MACHINE LEARNING
- CEE 690 with the topic NUMERICAL OPTIMIZATION

ME 555 with one of these topics: AUTONOMOUS SYSTEMS ENGINEERING; HUMAN FACTORS ENGINEERING

Hardware Design Take at least 9 credits that match the following:

- ECE 526 ECE 532 ECE 538 ECE 539 ECE 550D ECE 552 ECE 554 ECE 555 ECE 559 ECE 561 ECE 562 ECE 652
- ECE 590 with one of these topics: ENTERPRISE STORAGE ARCH; ENTERPRISE STORAGE ARCHITECTUR

Microelectronics, Photonics, and Nanotechnology Take at least 9 credits that match the following:

- ECE 511 ECE 512 ECE 521 ECE 523 ECE 526 ECE 527 ECE 528 ECE 529 ECE 532 ECE 533 ECE 546 ECE 722 NANOSCI 511

Quantum Computing Take at least 9 credits that match the following:

- ECE 521 ECE 523 ECE 550D ECE 551D ECE 571 ECE 575 ECE 577 ECE 650 ECE 651
- ECE 590 with one of these topics: GRAD INTRO QUANTUM ENGINEERING; QUANTUM ERROR CORRECTION; QUANTUM INFORMATION SCIENCE II

Software Development Take at least 9 credits that match the following:

- ECE 550D ECE 551D ECE 553 ECE 555 ECE 558 ECE 563 ECE 564 ECE 565 ECE 650 ECE 651
- ECE 590 with one of these topics: ENGINEERING ROBUST SERVER SOFT; ENTERPRISE STORAGE ARCH; ENTERPRISE STORAGE ARCHITECTUR

Departmental Requirements

Fulfill all of the following requirements

Technical Courses Take at least 6 credits that match the following:

- ECE 500 to ECE 799

Technical Electives Take at least 9 credits that match the following:

- ECE 899 (Maximum of 2 of these courses allowed)
- AIPI 510 to AIPI 590L
- BME 500 to BME 850
- CEE 500 to CEE 890
- COMPSCI 507D to COMPSCI 699
- CYBERSEC 510 to CYBERSEC 590L
- ECE 500 to ECE 781
- EGRMGMT 510 to EGRMGMT 590L
- FINTECH 510 to FINTECH 590L
- IDS 590 to IDS 990S
- ME 500 to ME 775

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: iapse.dukekunshan.edu.cn/about-ece

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 high-tech research and manufacturing, and has 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.

Academic Requirements

Duke Kunshan University MEng students must complete 30.0 course credits composed of key program elements as follows:

- Two core industry preparatory courses (6.0 course credits)
 - Management of High Tech Industries
 - Business Fundamentals for Engineers
- Three core Electrical and Computer Engineering (ECE) concentration electives (9.0 course credits)
 - Concentration areas: Software development or big data analysis
- Two graduate technical electives (6.0 course credits)
- Three approved electives (9.0 course credits)
- Language and professional training courses (0 course credits)
- Summer Internship (0 course credits)

Core Industry Preparatory Courses

The core industry preparatory courses provide students with the skills they need to succeed in the industry. Business savvy and technical expertise gained in the Duke Kunshan University MEng Program will help students understand and work effectively in a corporate climate.

Master of Engineering (E-EGR)

Master of Engineering in Environmental Engineering

Program Code: E-EGR-ENV

Degree Designation: Master of Engineering

Department: Engineering Management Program

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

Duke University

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

- Fulfill all of the following requirements
- Must maintain Program GPA of at least 2.999

Core Industry Preparatory Courses

Fulfill all of the following requirements

- MENG 540 Management of High Tech Industries
- MENG 570 Business Fundamentals for Engineers

Internship/Project and Assessment

Fulfill all of the following requirements

- MENG 550 Master of Engineering Internship/Project
- MENG 551 Master of Engineering Internship/Project Assessment

Seminar

Fulfill any of the following requirements

- CEE 701 Graduate Colloquium
- CEE 702 Graduate Colloquium

Departmental Requirements

Applied Mathematics, Statistics, and Data Science Take at least 3 credits that match the following:

- CEE 501 CEE 502 CEE 628 CEE 675 ENVIRON 764 STA 601 STA 601L STA 611
- CEE 690 with one of these topics: ENV SPATIAL DATA ANALYSIS; HEALTH AND ENV DATA SCIENCE; RISK AND RESILIENCE IN ENGR; UNCERTAINTY QUANTIFICATION

Atmospheric and Hydrologic Processes Take at least 3 credits that match the following:

- CEE 575 CEE 581 CEE 683 CEE 684 CEE 688 ENVIRON 603 ENVIRON 604 ENVIRON 734L
- CEE 690 with one of these topics: AIR POLLUTION ENGINEERING; HYDROLOGY; TURBULENCE

Biosciences Take at least 3 credits that match the following:

- CEE 562 CEE 562L CEE 566 CEE 661L
- CEE 690 with one of these topics: MODEL ENV CHEM BIO ENERG PROC; MODELING ENV CHEM BIO PROCESS

Chemistry Take at least 3 credits that match the following:

- CEE 561L CEE 563 CEE 565 CEE 666 CEE 667

Engineered Systems Take at least 3 credits that match the following:

- CEE 562 CEE 562L CEE 564 CEE 575
- CEE 690 with the topic AIR POLLUTION ENGINEERING

Transport Processes and Modeling Take at least 3 credits that match the following:

- CEE 531 CEE 560 CEE 581 CEE 683

Duke University

- CEE 690 with one of these topics: ENV FLUID MECH & SEDIMENT TRAN; MODEL ENV CHEM BIO ENERG PROC; MODELING ENV CHEM BIO PROCESS

Electives

Take at least 9 credits that match the following:

- CEE 501 CEE 502 CEE 531 CEE 560 CEE 561L CEE 562 CEE 562L CEE 563 CEE 564 CEE 565 CEE 566 CEE 575 CEE 581 CEE 628 CEE 642 CEE 661L CEE 666 CEE 667 CEE 675 CEE 679 CEE 683 CEE 684 CEE 688 CEE 761 ENERGY 727 ENVIRON 502 ENVIRON 520 ENVIRON 531L ENVIRON 552 ENVIRON 559 ENVIRON 563 ENVIRON 577 ENVIRON 603 ENVIRON 604 ENVIRON 638 ENVIRON 640 ENVIRON 711 ENVIRON 734L ENVIRON 740 ENVIRON 741 ENVIRON 764 MATH 561 ME 536 ME 537 ME 631 ME 632 ME 639 PUBPOL 577 PUBPOL 811 PUBPOL 813 STA 601 STA 601L STA 611
- CEE 690 with one of these topics: AIR POLLUTION ENGINEERING; ENV FLUID MECH & SEDIMENT TRAN; ENVIRONMENTAL CHEMINFORMATICS; ENV SPATIAL DATA ANALYSIS; HEALTH AND ENV DATA SCIENCE; HYDROLOGY; INTRO TO DEEP LEARNING; MODEL-BASED DATA SCIENCE; MODEL ENV CHEM BIO ENERG PROC; MODELING ENV CHEM BIO PROCESS; RISK AND RESILIENCE IN ENGR; TURBULENCE; TURBULENCE II; UNCERTAINTY QUANTIFICATIONS

Master of Engineering (E-EGR)

Master of Engineering in Financial Technology

Program Code: E-EGR-FNTK

Degree Designation: Master of Engineering

Department: Financial Technology

Website: fintech.meng.duke.edu/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.

Academic Requirements

- Fulfill all of the following requirements
- Must maintain Program GPA of at least 2.999

Core Industry Preparatory Courses

Fulfill all of the following requirements

- MENG 540 Management of High Tech Industries
- MENG 570 Business Fundamentals for Engineers

Internship/Project and Assessment

Fulfill all of the following requirements

- MENG 550 Master of Engineering Internship/Project
- MENG 551 Master of Engineering Internship/Project Assessment

Technical Core

Fulfill all of the following requirements

- FINTECH 501 Financial Technology Seminar
- FINTECH 510 Programming for FinTech
- FINTECH 512 Software Engineering for FinTech

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- FINTECH 520 Financial Institution Products & Services
- FINTECH 522 Asset Pricing and Risk Management

FinTech Capstone

Fulfill all of the following requirements

- FINTECH 502 FinTech Capstone

Electives

Take at least 9 credits that match the following:

- ECE 564 FINTECH 514 FINTECH 533 FINTECH 534 FINTECH 535 FINTECH 536 FINTECH 540 FINTECH 545 FINTECH 550 FINTECH 552 FINTECH 564 FINTECH 565 FINTECH 590 LAW 581

Master of Engineering (E-EGR)

Master of Engineering in Financial Technology—Online

Program Code: E-EGR-FNTO

Degree Designation: Master of Engineering

Department: Financial Technology

Website: fintech.meng.duke.edu/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

- Fulfill all of the following requirements
- Must maintain Program GPA of at least 2.999

Core Industry Preparatory Courses

Fulfill all of the following requirements

- MENG 540 Management of High Tech Industries
- MENG 570 Business Fundamentals for Engineers

Internship/Project and Assessment

Fulfill all of the following requirements

- MENG 550 Master of Engineering Internship/Project
- MENG 551 Master of Engineering Internship/Project Assessment

Residency

Fulfill all of the following requirements

- FINTECH 505 Mid-Program Residency

Technical Core

Fulfill all of the following requirements

- FINTECH 501 Financial Technology Seminar

Duke University

- FINTECH 510 Programming for FinTech
- FINTECH 512 Software Engineering for FinTech
- FINTECH 520 Financial Institution Products & Services
- FINTECH 522 Asset Pricing and Risk Management

FinTech Capstone

Fulfill all of the following requirements

- FINTECH 502 FinTech Capstone

Electives

Take at least 9 credits that match the following:

- ECE 564 FINTECH 514 FINTECH 533 FINTECH 534 FINTECH 535 FINTECH 536 FINTECH 540 FINTECH 545 FINTECH 550 FINTECH 552 FINTECH 564 FINTECH 565 FINTECH 590 LAW 581
- EGRMGMT 590 with the topic STARTUP FUNDAMENTALS & STRATEGY

Master of Engineering (E-EGR)

Master of Engineering in Materials Science and Engineering

Program Code: E-EGR-MSE

Degree Designation: Master of Engineering

Department: Engineering Management Program

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

Master of Engineering students complete 30 credits, comprised of key program elements as follows:

Core industry preparatory courses

(2 courses, 6 credits)

- MENG 540: Management of High Tech Industries
- MENG 570: Business Fundamentals for Engineers

Discipline-specific or interdisciplinary core courses

(5-6 courses, 15-18 credits, varies by department)

The Master of Engineering program in the discipline of materials engineering and science has a defined set of requirements designed to give you in-depth technical knowledge. Our MSE master's program gives you flexibility in course selection within your engineering discipline.

Technical electives in a concentrated area

(2-3 courses, 6-9 credits, varies by department)

Technical elective options give you more opportunity to specialize in your area of interest, and take advantage of Duke's leading status in materials science and engineering. Specializations like these will distinguish you with potential employers. You will work with a faculty advisor to customize a curriculum that suits you. In some cases, an independent study sponsored by a faculty member may satisfy an elective requirement.

Internship

- MENG 550: Master of Engineering Internship/Project
- MENG 551: Master of Engineering Internship/Project Assessment

We require all MEng students to engage in an internship or project to complete the program. The many options available to fulfill this

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requirement give you a chance to practice what you're learning, ask questions, and hone your skills in a supportive environment. Internships may be paid or unpaid, corporate or governmental. Projects may take the form of applied research positions, provided the learning objectives are met.

Once your project or internship is completed, you will prepare a written and/or oral project report. Individual programs/majors may have additional requirements or exceptions to fulfill the internship component of the program.

Master of Engineering (E-EGR)

Master of Engineering in Mechanical Engineering

Program Code: E-EGR-ME

Degree Designation: Master of Engineering

Department: Engineering Management Program

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

- 2 Industry preparation courses
 - MEng 540: Leadership & Management
 - MEng 570: Business Fundamentals
- 5 Courses in your area of study
- 3 Elective courses
- 1 Internship
 - MEng 550: Internship or Project
 - MEng 551: Internship Assessment

Master of Engineering (E-EGR)

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

Take at least 2 courses that match the following:

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- BME 790L with the topic ADVANCED DESIGN AND MANUFACTUR
- BME 590L with the topic MEDICAL ELECTRICAL EQUIPMENT

Design Health Sequence

Fulfill all of the following requirements

Design Health Sequence I Take at least 1 course that matches the following:

- BME 773L
- BME 790L with the topic ADVANCED BIOMEDICAL DESIGN I

Design Health Sequence II Take at least 1 course that matches the following:

- BME 774L
- BME 790L with the topic ADVANCED BME DESIGN II

Design Health Sequence III

Take at least 1 course that matches the following:

- BME 790L with the topic ADVANCED BIOMEDICAL DESIGN III

Take at least 1 course that matches the following:

- BME 775L

Business and Management

Take at least 3 courses that match the following:

- MENG 540
- BME 590 with one of these topics: BUSINESS IN BME; QUALITY SYSTEMS FOR BME

Elective Requirements

Fulfill all of the following requirements

Advanced Math Courses Take at least 1 course that matches the following:

- BME 671L CBB 540 CEE 530 CEE 630 COMPSI 520 MATH 545 MATH 551 MATH 561 MATH 563 MATH 565 MATH 577 MATH 660 MATH 721 MATH 753 PHYSICS 760 STA 602L STA 611 STA 621
- BME 790L with the topic COMP LINEAR ALGEBRA IN BME

Life Science Courses Take at least 1 course that matches the following:

- BIOCHEM 536 BIOCHEM 622 BIOCHEM 681 BME 644 CBB 520 CELLBIO 730 CELLBIO 761 CELLBIO 762 CELLBIO 763 CHEM 536 CMB 797 EVANTH 530 IMMUNOL 544 IMMUNOL 800 MEDPHY 505 MGM 701 MGM 732 NEUROBIO 719 NEUROBIO 720 NEUROBIO 759S NEUROBIO 760S PATHOL 725 PATHOL 750
- BME 790 with one of these topics: PHYSIOLOGY FOR ENGINEERS; QUANTITATIVE PATHOPHYSIOLOGY

Internship Courses

Fulfill all of the following requirements

- MENG 549 Career Preparation
- MENG 550 Master of Engineering Internship/Project
- MENG 551 Master of Engineering Internship/Project Assessment

Master of Engineering (E-EGR)

Master of Engineering in Photonics and Optical Sciences

Program Code: E-EGR-POS

Degree Designation: Master of Engineering

Department: Engineering Management 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

- Fulfill all of the following requirements
- Must maintain Program GPA of at least 2.999

Core Industry Preparatory Courses

Fulfill all of the following requirements

- MENG 540 Management of High Tech Industries
- MENG 570 Business Fundamentals for Engineers

Internship/Project and Assessment

Fulfill all of the following requirements

- MENG 550 Master of Engineering Internship/Project
- MENG 551 Master of Engineering Internship/Project Assessment

Departmental Requirements

Fulfill all of the following requirements

Advanced Mathematics Course Take at least 3 credits that match the following:

- BME 671L MATH 551 MATH 561 MATH 577 PHYSICS 760

Optics/Photonics Courses Take at least 6 credits that match the following:

- BME 552 BME 555 ECE 541 PHYSICS 621

Technical Optics/Photonics Courses Take at least 6 credits that match the following:

- BME 550 BME 553 ECE 523 ECE 545 ECE 546 ECE 573 ECE 675 ECE 722 PHYSICS 562 PHYSICS 627 PHYSICS 719
- ECE 590 with the topic NONLINEAR OPTICS
- BME 590 with the topic BIOMEDICAL OPTICS

Technical Electives

Fulfill all of the following requirements

BME or ECE Course Take at least 3 credits that match the following:

- BME 500 to BME 850
- ECE 500 to ECE 781

Technical Engineering Take at least 6 credits that match the following:

- AIPi 510 to AIPi 590L

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- BME 500 to BME 850
- CEE 500 to CEE 890
- CYBERSEC 510 to CYBERSEC 590L
- ECE 500 to ECE 781
- EGRMGMT 510 to EGRMGMT 590L
- FINTECH 510 to FINTECH 590L
- ME 500 to ME 775

Master of Engineering (E-EGR)

Master of Engineering in Risk Engineering

Program Code: E-EGR-RE

Degree Designation: Master of Engineering

Department: Engineering Management Program

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

- Fulfill all of the following requirements
- Must maintain Program GPA of at least 2.999

Core Industry Preparatory Courses

Fulfill all of the following requirements

- MENG 540 Management of High Tech Industries
- MENG 570 Business Fundamentals for Engineers

Internship/Project and Assessment

Fulfill all of the following requirements

- MENG 550 Master of Engineering Internship/Project
- MENG 551 Master of Engineering Internship/Project Assessment

Seminar

Fulfill any of the following requirements

- CEE 701 Graduate Colloquium
- CEE 702 Graduate Colloquium

Uncertainty, Risk, and Systems Engineering Requirements

Take at least 6 credits that match the following:

- CEE 690 with the topic RISK AND RESILIENCE IN ENGR
- EGRMGMT 590 with the topic SYSTEMS ENGINEERING

Methodological Requirements

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Fulfill any 3 of the following requirements

Mathematical Modeling Optimization Take at least 3 credits that match the following:

- CEE 627 CEE 629 MATH 551 MATH 555 MATH 561 MATH 577 PHYSICS 513
- CEE 690 with the topic NUMERICAL OPTIMIZATION

Policy Analysis Take at least 3 credits that match the following:

- LAW 590 PUBPOL 504 PUBPOL 505S PUBPOL 580S PUBPOL 582 PUBPOL 583S PUBPOL 585 PUBPOL 607

Uncertainty Quantification and Data Analytics Take at least 3 credits that match the following:

- CEE 644 COMPSCI 571D COMPSCI 579 ECE 555 ECE 581 ECE 585 MATH 541 STA 502 STA 601 STA 601L STA 611 STA 623
- CEE 690 with the topic UNCERTAINTY QUANTIFICATION

Valuation, Assessment, and Decision Making Take at least 3 credits that match the following:

- CEE 679 ECON 753 ENVIRON 520 ENVIRON 521 ENVIRON 638 ENVIRON 640 ENVIRON 717

Concentration Requirements

Fulfill any of the following requirements

Energy and Climate Systems Take at least 9 credits that match the following:

- CEE 575 ENERGY 630 ENERGY 631 ENERGY 635 ENERGY 711 ENERGY 716L EOS 512

Environment and Population Health Take at least 9 credits that match the following:

- CEE 560 CEE 561L CEE 563 CEE 571 CEE 581 CEE 667 CEE 683 CEE 684 ENVIRON 539 ENVIRON 563

Materials and Structures Take at least 9 credits that match the following:

- CEE 520 CEE 525 CEE 541 CEE 621 CEE 642 ME 527 ME 555 ME 742
- BME 590 with the topic VISCOELASTIC BIOMECHANICS

Master of Engineering Management

Program Code: E-MGT-MEG & E-MGT-DME

Degree Designation: Master of Engineering Management

Department: Engineering Management Program

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.

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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 (E-MGT)

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 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. Any suspension, dismissal, or graduation decision may be appealed within seven days to the Associate Dean for Research and Infrastructure.

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 MEM Program Admissions Committee, and appeals will be heard by the Associate Dean for Research and Infrastructure.

Advising

Each MEM student is assigned a Faculty Academic Advisor (also known as a Faculty Mentor Coach) who is available to assist with questions regarding topics such as career direction and academic preparation for the student's desired career.

These advisors are available as a resource. An advisor will not contact a student individually to set up a meeting. Students seeking advice should contact their advisor to discuss questions or to arrange for a meeting time. Even if an advisor's background differs from the student's own, they can be a very helpful resource.

As a graduate student, academic advising is very different from advising as an undergraduate. Students should not rely on their advisors to make their own course decisions. Students should make sure to assess their individual career interests and the knowledge required to be successful in the field, and then identify potential course options consistent with their personal career goals before meeting with their advisor. The student's advisor can then provide advice about final course decisions.

Career Strategy and Design Course (EGR 590-1)

Duke University

Career Strategy and Design is a one-credit, six-week intensive 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 students matriculating in the MEM On-Campus program in the Fall 2023 semester.

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 in writing to the Associate Dean of Master's Programs.

Course Enrollments and Registration

MEM courses generally follow the timeline for graduate student registration as designated by the University Registrar's Office (registrar.duke.edu/academic-calendar). This calendar applies to engineering management courses and courses under The Graduate School's oversight. 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

Beginning with the Fall 2023 semester, MEM On-Campus students will complete core courses in 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 and the MEM Program director (see Audit Courses Policy and Permission form on the MEM Student Resources website). 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.

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. 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.

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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 GPA calculation.

Course Withdrawals

The Graduate School and The Fuqua School of Business set Drop/Add dates for their respective courses and those dates are followed accordingly. If a course is dropped after the Drop/Add period, the status of the student at the time of withdrawal from the course will be indicated on their permanent record as a withdrawal (W). To withdraw from a course, fill out the Course Withdrawal Form on the MEM Student Resources website. A student seeking a course withdrawal will first meet with their academic dean 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 dean, the student will seek a signature from the course instructor. This policy 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 without a W generally is the last day of the Drop/Add period. The last day to withdraw from a course with a W is the last day of classes for each semester.

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/students. 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.

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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.

Extending the Duration of MEM Program

Master of Engineering Management On-Campus Program

The Master of Engineering Management degree can be earned in one to two years. 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. All students in their final semester must register for at least 3.0 tuition-bearing units (this does not include EGRMGMT 550, EGRMGMT 551, or EGRMGMT 552).

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

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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 to the Senior Associate Dean for the Pratt School of Engineering. Any appeal must be made in writing and must include a description of the error that was made in assigning a grade.

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:
 - Engineering Management 510 (Marketing)
 - Engineering Management 520 (Intellectual Property, Business Law, and Entrepreneurship)
 - Engineering Management 530 (Finance and Accounting for Technology-Based Companies)
 - Engineering Management 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 (Engineering Management 550 and Engineering Management 551)
- Career Design and Strategy (EGR 590-1: Special Topics: Career Design & Strategy)*
- Two semesters of the MEM Seminar and Workshop Series (Engineering Management 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.)

*The one-credit, six-week intensive Career Design and Strategy course is a degree requirement for students matriculating in the MEM On-Campus Program in the Fall 2023 semester.

**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 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:

- Engineering Management 510 (Marketing)

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- Engineering Management 520 (Intellectual Property, Business Law, and Entrepreneurship)
- Engineering Management 530 (Finance in High-Tech Industries)
- Engineering Management 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

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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: Engineering Management 510 (Marketing), Engineering Management 530 (Finance in High-Tech Industries), and Engineering Management 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 Engineering Management 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/interinstitutional-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, 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, students must submit their academic and Joint Services Transcripts to the academic coordinator after admission to 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.

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 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

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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

Students who exhibit harmful, potentially harmful, or disruptive behavior toward themselves or others may be subject to involuntary administrative withdrawal from the university if their behavior renders them unable to effectively function in the university community.

Such behavior includes, but is not limited to, that which

- poses a significant threat of danger and/or harm to self and/or other members of the university community; and/or
- interferes with the lawful activities or basic rights of other students, university employees, or visitors.

Any member of the university community who has reason to believe that a student may meet the standard for an involuntary administrative withdrawal may contact the Vice President for Student Affairs or their designee. The vice president or designee will conduct a preliminary review in consultation with professionals from Student Health and/or Counseling and Psychological Services, the Associate Dean of Master's Programs, and/or other relevant individuals. The vice president or designee will meet, when possible, with the student in question to discuss the information that has been presented and give the student an opportunity to respond. The vice president or designee may mandate that the student be evaluated by a specified health professional within a given time frame if an evaluation has not already been conducted. In the instances described above, the Vice President for Student Affairs or designee will make the final decision about involuntary administrative withdrawal. A written statement citing the reasons will be forwarded to Associate Dean of Master's Programs, who will withdraw the student from the university. At any point in the process, the student may request a voluntary withdrawal via the Associate Dean of Master's Programs.

Master of Engineering Management (E-MGT)

Academic Requirements

- Fulfill all of the following requirements
- Must maintain Program GPA of at least 3.0

Core Courses

Fulfill all of the following requirements

- 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

Engineering Management Seminar

- Repeat EGRMGMT 501 at least 2 times

Engineering Management Internship

Fulfill all of the following requirements

- EGRMGMT 550 Engineering Management Internship
- EGRMGMT 551 Engineering Management Internship Assessment

Electives

Take at least 12 credits that match the following:

- AIP1 510 to AIP1 590L
- BME 500 to BME 850
- CEE 500 to CEE 890
- CYBERSEC 510 to CYBERSEC 590L
- ECE 500 to ECE 781
- EGRMGMT 512 to EGRMGMT 590L

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- FINTECH 510 to FINTECH 590L
- ME 500 to ME 775
- FINANCE 898 with the topic Project Finance
- ISS 591 with the topic HOW DO CYBERATTACKS HURT ME?
- EGR 590 with the topic ELUMINATE- DESIGN&INNOV STUDIO
- ENERGY 590 with the topics INTRO TO SOLAR PROJECT DEV; EMERGING ENERGY TECHNOLOGIES
- ENVIRON 590 with the topic SUSTAINABLE CITIES
- COMPSCI 590 with one of these topics: COMP INFO LEARN MARKET DESIGN; COMPUTATIONAL MICROECONOMICS; DATA CENTER SYSTEMS
- ENVIRON 790 with the topic BUILT ENVIRONMENT
- PUBPOL 590S with the topic HUMAN CENTERED DESIGN
- ACCOUNTG 597 ACCOUNTG 598 BA 901 BA 910 BA 925 BA 991 CELLBIO 503 CHEM 501 CHEM 511 COMPSCI 510 COMPSCI 512 COMPSCI 514 COMPSCI 516 COMPSCI 527 COMPSCI 531 COMPSCI 532 COMPSCI 571D COMPSCI 662 COMPSCI 671D DECISION 611 DECISION 613 DECISION 614 DECISION 617 ECON 571 ECON 572 ECON 601 ECON 602 ECON 608D ECON 620 ECON 652 ECON 673 ECON 674 ECON 703 ENERGY 590 ENERGY 620 ENERGY 630 ENERGY 631 ENERGY 635 ENERGY 638 ENERGY 715L ENERGY 716L ENERGY 727 ENERGY 790 ENERGY 811 ENRGYENV 625 ENRGYENV 626 ENRGYENV 627 ENVIRON 520 ENVIRON 521 ENVIRON 535 ENVIRON 559 ENVIRON 577 ENVIRON 593 ENVIRON 635 ENVIRON 638 ENVIRON 710 ENVIRON 711 ENVIRON 715L ENVIRON 716L ENVIRON 717 ENVIRON 752 ENVIRON 761 ENVIRON 767 ENVIRON 811 ENVIRON 830 ENVIRON 831 ENVIRON 832 ENVIRON 835 ENVIRON 859 ENVIRON 872L FINANCE 646 FINANCE 647 FINANCE 648 FINANCE 651 FINANCE 653 FINANCE 654 FINANCE 656 FINANCE 657 FINANCE 658 FINANCE 661 FINANCE 662 FUQINTRD 697 GLHLTH 501 GLHLTH 690 GLHLTH 701 GLHLTH 750 GLHLTH 755 HLTHMGMT 710 HLTHMGMT 711 HLTHMGMT 712 HLTHMGMT 716 HLTHMGMT 717 I&E 510 I&E 710 I&E 720 I&E 721 I&E 748 I&E 750 I&E 752 I&E 800 I&E 835 IDS 701 IDS 702 IDS 703 IDS 704 IDS 705 IDS 706 IDS 707 IDS 720 LAW 235 LAW 270 LAW 321 LAW 346 LAW 347 LAW 353 LAW 375 MANAGEMT 738 MANAGEMT 750 MANAGEMT 754 MANAGEMT 896 MARKETNG 796 MARKETNG 797 MARKETNG 799 MARKETNG 800 MARKETNG 802 MARKETNG 803 MARKETNG 808 MARKETNG 896 MATH 531 MATH 532 MATH 551 MATH 575 MATH 581 MATH 582 MATH 757 MENG 570 MGMTCOM 896 MGRECON 781 MGRECON 784 MGRECON 788 NANOSCI 511 NURSING 967 OPERATNS 820 OPERATNS 822 OPERATNS 823 OPERATNS 824 OPERATNS 827 OPERATNS 828 PHARM 533 PHARM 554 PUBPOL 511 PUBPOL 598 PUBPOL 743 PUBPOL 770 PUBPOL 776 PUBPOL 820 PUBPOL 890 SCISOC 585 STA 502 STA 521L STA 561D STA 601 STA 611 STA 621 STA 623 STA 663L STA 671D STA 711 STA 732 STA 831 STA 863 STRATEGY 627 STRATEGY 838 STRATEGY 842 STRATEGY 843 STRATEGY 845 STRATEGY 848 STRATEGY 849 STRATEGY 850 STRATEGY 851 STRATEGY 852 STRATEGY 896 ZZZ 999

Master of Engineering Management (E-MGT)

MEM Online Academic Requirements

Fulfill all of the following requirements

Must maintain Program GPA of at least 2.999

Core Courses

Fulfill all of the following requirements

- 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

Residency

Fulfill all of the following requirements

- EGRMGMT 504 Residency 1 - Introduction
- EGRMGMT 505 Residency 2 - Mid-Program
- EGRMGMT 506 Residency 3 - Conclusion and Graduation

Engineering Management Internship

Fulfill all of the following requirements

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- EGRMGMT 550 Engineering Management Internship
- EGRMGMT 551 Engineering Management Internship Assessment

Electives

Take at least 12 credits that match the following:

- ZZZ 999
- Course that matches one of the following patterns: AIPI 5; **EGRMGMT 5**; FINTECH 5**

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
- Medical Device Design
- Medical Robotics and Surgical Technologies
- Neural Engineering
- Robotics and Automation

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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.

Concurrent Graduate Certificates

Aerospace Certificate

Program Code: E-AEROSP-C

Degree Designation: Certificate

Department: Engineering Management Program

Website: mems.duke.edu/masters/certificates/aerospace

Program Summary

Professor Robert Kielb, Director of Certificate Program, Associate Professor of the Practice 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.

Academic Requirements

- Four technical courses
- Attend four 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: Engineering Management Program

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 Duke Hub. Once the student has completed the certificate requirements, the administrator and faculty advisor will review the student's transcript and

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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.

Academic Requirements

Students receiving the Data for Materials Science Masters/Doctoral Certificate will have completed at least four courses from the approved list of courses relevant to data science and materials science. The certificate administrator will routinely revise and update the acceptable courses list to reflect any relevant new course options. There will be no universal course prerequisite for enrollment in the program. This is in part because the needs of each student are diverse. Also, different courses may require a different level of proficiency in one or more programming languages, but students should have or develop proficiency in Python. The course instructors will set the prerequisites for enrollment in each course.

Courses (12 units, 4 classes)

- Select 1 Materials Science Foundations Course (see list)
- Select 1 Machine Learning Foundations Course (see list)
- Select 1 Machine Learning and Materials Applications Course (see list)
- Select either ML + Materials Project or Internship
 - Fall/Spring Data and Materials Science Capstone. 3 units
 - Other research project courses or independent study course with work related to machine learning and materials science may satisfy this requirement, but require pre-approval from certificate administrators and faculty team review.
 - Internship or external research experience related to machine learning and materials science. (approved as 3-4 unit course by DGS)

Materials Science Foundations Courses. Select 1

- ME 510: Diffraction and Spectroscopy
- ME 511: Computational Materials Science
- ME 512: Modern Materials
- ME 514: Theoretical and Applied Polymer Science
- ME 515: Electronic Materials
- ME 519: Molecular Modeling of Soft Materials
- ME 555 Intermediate Polymer Physics
- ME 562: Materials Synthesis and Processing (Recommended for non-materials science students)
- ME 563: Fundamentals of Soft Matter
- ME 564: Introduction to Polymer Physics
- ME 711: Nanotechnology Materials Lab
- CHEM 548 Solid-State/Materials Chemistry (Recommended for non-materials science students with some chemistry experience)
- CHEM 590 Polymer Synthesis
- CEE 520 Continuum Mechanics
- CEE 521 Elasticity
- ECE 511 Foundations of Nanoscale Science & Technology
- ECE 524 Introduction to Solid-State Physics
- PHYSICS 516 Quantum Materials

Machine Learning Foundation Courses. Select 1

- ME 555-09/CEE 690 Data Science and machine learning for applied science and engineering (Recommended for students with less computational experience)
- COMPSCI 671D: Theory and Algorithms for Machine Learning (Requires prior experience and comfort with Python programming, probability, and linear algebra)
- ECE 685D: Introduction to Deep Learning
- ECE 590: Advanced Deep Learning
- ECE 590: Computer Engineering ML and Deep Neural Nets
- ECE 682D/STA 561D: Probabilistic Machine Learning

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Machine Learning + Materials Applications Courses. Select 1

- ME 582 Data and Materials Science Applications
- ME 555: Sci Computing, Simulation and ML
- ME 555: Applications of Computational Materials

Concurrent Graduate Certificates

Biomedical Data Science Certificate

Program Code: E-DATSCI-C

Degree Designation: Certificate

Department: Engineering Management Program

Website: bme.duke.edu/masters/certificates/biomedical-data-science

Program Summary

Professor Sina Farsiu, Director of Certificate Program, Assistant 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 all Duke Master of Engineering (MEng) and Master of Science (MS) students intending to pursue careers or enter doctoral programs relating to biomedical data science.

Academic Requirements

- Complete all departmental requirements for a master's degree.
- Complete at least four (4) of the approved courses relevant to data science. At least two (2) of these courses must be offered through Duke BME.
- Complete a biomedical data science-relevant project and submit a two-page abstract and poster 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: Engineering Management Program

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 labs (denoted by the letter L in the course number):

- BME 562 Biology by Design
- BME 570L Introduction to Biomolecular Engineering
- BME 577 Drug Delivery
- BME 590L Biotechnology Design 1

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- BME 590L Biotechnology Design 2
- BME 590L Gene Engineering Lab
- BME 590 Synaptic Biology Synthetic Technology
- BME 790 Bioconjugation in Biomaterials
- BME 790L Bioconjugation Lab

Concurrent Graduate Certificates

Medical Device Design Certificate

Program Code: E-MEDDEV-C

Degree Designation: Certificate

Department: Engineering Management Program

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

The four (4) MedTech courses that fulfill this graduate certificate provide for 12 of the 30 course credits required for a Duke master's degree in biomedical engineering. The courses are:

- Advanced Design and Manufacturing, *or* Medical Electrical Equipment
- Design in Health Care 1, or Design in Health Care 3
- Design in Health Care 2
- Quality Management Systems

Concurrent Graduate Certificates

Medical Robotics and Surgical Technologies Certificate

Program Code: E-MRST-C

Degree Designation: Certificate

Department: Engineering Management Program

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 and, Science & Society. To apply, contact the Program Coordinator for Duke's NSF Traineeship in the Advancement of Surgical Technologies (TAST) program.

Academic Requirements

This certificate will be concurrent with the student's degree program and thus will be awarded upon degree completion.

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

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The following two courses are required:

- ME 555 Introduction to Medical Robotics and Surgical Technologies in Fall term only
- ME 555 Medical Robotics and Surgical Technologies Team Project in Spring term only

One course in Machine Learning:

- COMPSCI 590-07 Applied Natural Language Processing
- COMPSCI 571D/ECE 682D/STA561 D Probabilistic Machine Learning
- ECE 590-03 Machine Learning in Adversarial Settings
- ECE 590-06 Case Studies in Machine Learning Applications
- COMPSCI 671 D/ECE 590D Machine Learning
- COMPSCI 570/ECE 590D Artificial Intelligence
- ECE 590-002 Introduction to Deep Learning
- BME 590-006 Machine Learning in Imaging
- EGRMGMT 599 Machine Learning Principles and Applications
- ME 555 Data Drive Dynamics and Control

One Elective Course:

- ECE 590-26/ME 555-28 Robotic Systems Design
- ECE 590-25/ME 555-27 Autonomous Systems Engineering
- ME555-28 Robotic Systems Design
- ME 555-06 Introduction to Robotics
- ME 555-04: Engineering Technology in Urology Applications
- COMPSCI 527 Computer Vision
- BME 590-001 Design Medical/Assistive Devices
- BME 590-05 Biotech Design
- BME 547 Medical Software Design
- ECE 590-07 Human Centered Computing
- I&E 721-01 Design in Healthcare
- Surg Star Duke Surgical Technique and Review (STAR)
- ME 555 Lasers in Medicine
- BIOETHIC 602S Law, Research & Bioethics
- BIOETHIC 605S Contemporary Issues in Bioethics & Science Policy
- BIOETHIC 704/LAW 333 Science, Law, & Policy
- BIOETHIC 603S Clinical Bioethics & Health Policy
- BIOETHIC 605S Contemporary Issues in Bioethics & Science Policy
- BIOETHIC 680S Ethical Foundations of Innovative Technology Policy
- BIOETHIC 704 Frontier Robotics
- I&E Intellectual Property Law: Law, Policy and Practice
- BME 590 Biomedical Device Innovation
- I&E 590-01 Special Topics I&E Global Health Practicum
- EGRMGMT 520 Intellectual Property Business Law and Entrepreneurship
- EGRMGMT 590 Intellectual Asset Management

Students must complete either an internship or present a research project through:

- A project presentation
- Poster defense
- Thesis defense

Concurrent Graduate Certificates

Neural Engineering Certificate

Program Code: E-NEURAL-C

Degree Designation: Certificate

Duke University

Department: Engineering Management Program

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

- Fulfill all of the following requirements
- Courses may double count without any limit with other programs unless specified otherwise

BME 601L Introduction to Neural Engineering

Physiology Course

Take at least 1 course that matches the following:

- BME 790L with the topic QUANTITATIVE PATHOPHYSIOLOGY
- BME 790 with one of these topics: PHYSIOLOGY FOR ENGINEERS; QUANTITATIVE PATHOPHYSIOLOGY

Neural Electives

Take at least 3 courses that match the following:

- BME 502 BME 503 BME 504 BME 511L BME 515 BME 517 BME 518L NEUROBIO 759S
- BME 590 with one of these topics: DEEP NET MODELS OF THE BRAIN; SYNAPTIC BIO SYNTHETIC TECH
- BME 590L with the topic BIOPOT AMPS & IMPLANT DEVICES

Concurrent Graduate Certificates

Robotics and Automation Certificate

Program Code: E-ROBOT-C

Degree Designation: Certificate

Department: Engineering Management Program

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

4 courses in total: "Advanced Robotics" and "Robot Learning" are required, select 1 course from the controls and dynamics track, and select 1 course from any of the tracks. The certificate administrator will routinely revise and update the acceptable courses list to reflect any relevant new course options.

Robotics Track

- ME 555/ECE 590 Advanced Robotics
- ME 555 Robot Learning

Controls and Dynamics Track

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- ME 541 Intermediate Dynamics
- ME 627 Linear System Theory
- ME 555 Model Predictive Control

Machine Learning Track

- ME 555 Data Driven Dynamical Systems and Control
- ECE 580 Introduction to Machine Learning
- ECE 685D Introduction to Deep Learning
- ECE 590-05 Advanced Topics in Deep Learning
- COMPSCI 570 Artificial Intelligence
- COMPSCI 590 Neurosymbolic ML
- COMPSCI 572 Natural Language Processing
- COMPSCI 671D Theory and Alg Machine Learning
- ECE 682D Probabilistic Machine Learning
- CEE 690/ME 555 Advanced Topics in CEE Data Sci & ML Appl Sci & Eng

Electives Track

- ME 555 Robot Studio
- COMPSCI 527 Computer Vision
- ME 555 Ethics of Case Studies in Robotics and Automation
- ECE 590/BIOETHIC 676S Ethical Technology Practicum
- ME 555/ECE 590 Introduction to Robotics
- ME 555 Medical Robotics and Surgical Technologies
- ECE 461/ME 555 Ocean Engineering
- ECE 588 Image and Video Processing: From Mars to Hollywood with a Stop at the Hospital

E-portfolio

Students are expected to use work from [internship, research project, and/or class project] to develop an e-portfolio that will be evaluated to demonstrate practical experience in robotics.

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

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: Engineering Management Program

Website: ai.meng.duke.edu/certificate

Program Summary

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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 core Master of Engineering in Artificial Intelligence for Product Innovation program online courses (12 units). In addition to the four core courses, certificate students are required to participate in a Python programming boot camp.

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);
- A minimum of one (1) semester of programming (any language);
- Sufficient DUOLINGO, IELTS, or TOEFL English Language Testing scores (official results required; international students only); and
- Two (2) semesters of calculus.

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

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 the time of application) and complete all course requirements for the degree.

Academic Requirements

Fulfill all of the following requirements:

Count courses only from the given course set: Course with an enrollment tag EGRP.

Pre-Program Bootcamp

Fulfill all of the following requirements:

- AIPI 503 Python Bootcamp (0 units)

AIPI 510 Sourcing Data for Analytics (3 units)

AIPI 520 Modeling Process and Algorithms (3 units)

AIPI 530 or AIPI 531

Fulfill one of the following requirements:

- AIPI 530 Optimization in Practice (3 units)
- AIPI 531 Deep Reinforcement Learning Applications (3 units)

AIPI 540 Deep Learning Applications (3 units)

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

Fulfill all of the following requirements

- 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

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:

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- 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:

- 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

Subject	Catalog Number	Title
AIPI	501	AIPI Seminar
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.		

AIPI502 - AIPI Workshops

Subject	Catalog Number	Title
AIPI	502	AIPI Workshops
Description		
Workshops provide opportunities to develop and improve professional skills. Selected topics support student success within industry roles.		

AIPI503 - Python Bootcamp

Subject	Catalog Number	Title
AIPI	503	Python Bootcamp

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.

AIPI504 - Introductory Residency

Subject	Catalog Number	Title
AIPI	504	Introductory Residency

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.

AIPI505 - Mid-Program Residency

Subject	Catalog Number	Title
AIPI	505	Mid-Program Residency

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.

AIPI506 - Concluding Residency

Subject	Catalog Number	Title
AIPI	506	Concluding Residency

Description

One week course to conclude the Master of Engineering in AI for Product Innovation Online Program. Residency 3 includes capstone project presentations, team-building exercises, case studies, professional development workshops, and exit interviews. Prerequisite: Enrollment in the Master of Engineering in AI for Product Innovation Online Program.

AIPI510 - Sourcing Data for Analytics

Subject	Catalog Number	Title
AIPI	510	Sourcing Data for Analytics

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.

AIPI520 - Modeling Process and Algorithms

Subject	Catalog Number	Title
AIPI	520	Modeling Process and Algorithms

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.

AIPI530 - Optimization in Practice

Subject	Catalog Number	Title
AIPI	530	Optimization in Practice

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.

AIPI531 - Deep Reinforcement Learning Applications

Subject	Catalog Number	Title
AIPI	531	Deep Reinforcement Learning Applications

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.

AIPI540 - Deep Learning Applications

Subject	Catalog Number	Title
AIPI	540	Deep Learning Applications

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.

AIPI549 - Capstone Practicum 1

Subject	Catalog Number	Title
AIPI	549	Capstone Practicum 1

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. Prerequisites: Enrollment in the Master of Engineering in AI for Product Innovation Program, AIPI 510, 520, 530.

AIPI560 - Legal, Societal, and Ethical Implications of AI

Subject	Catalog Number	Title
AIPI	560	Legal, Societal, and Ethical Implications of AI

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.

AIPI561 - Operationalizing AI

Subject	Catalog Number	Title
AIPI	561	Operationalizing AI

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.

AIPI590 - Advanced Topics in AI for Products Innovation

Subject	Catalog Number	Title
AIPI	590	Advanced Topics in AI for Products Innovation

Description

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

AIPI590L - Advanced Topics in AI for Products Innovation (with Lab)

Subject	Catalog Number	Title
AIPI	590L	Advanced Topics in AI for Products Innovation (with Lab)

Description

Opportunity for study of advanced subjects with laboratory related to programs within AI for Product Innovation tailored to fit the requirements of a small group. Permission of instructor required.

AIPI591 - Special Readings in AI for Product Innovation

Subject	Catalog Number	Title
AIPI	591	Special Readings in AI for Product Innovation

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.

BME503 - Computational Neuroengineering (GE, EL)

Subject	Catalog Number	Title
BME	503	Computational Neuroengineering (GE, EL)

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.

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

Subject	Catalog Number	Title
BME	504	Fundamentals of Electrical Stimulation of the Nervous System (EL, GE)

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)

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

Subject	Catalog Number	Title
BME	505L	Biopotential Amplifiers and Implant Devices (GE, EL, IM)

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).

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

Subject	Catalog Number	Title
BME	506	Measurement and Control of Cardiac Electrical Events (GE, EL, IM)

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.

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

Subject	Catalog Number	Title
BME	507	Cardiovascular System Engineering, Disease and Therapy (GE, BB, EL)

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.

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

Subject	Catalog Number	Title
BME	510	Bayesian Analysis in Biomedical Engineering (GE, EL)

Description

The application of Bayesian statistics to questions in BME broadly with a focus on electrocardiography. 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.

BME512L - Cardiac Bioelectricity (GE, EL)

Subject	Catalog Number	Title
BME	512L	Cardiac Bioelectricity (GE, EL)

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.

BME513 - Introduction to Neurodynamics (EL, GE)

Subject	Catalog Number	Title
BME	513	Introduction to Neurodynamics (EL, GE)

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)

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

Subject	Catalog Number	Title
BME	515	Neural Prosthetic Systems (GE, EL, IM)

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.

BME517 - Neuronal Control of Movement (GE, EL)

Subject	Catalog Number	Title
BME	517	Neuronal Control of Movement (GE, EL)

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.

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

Subject	Catalog Number	Title
BME	518L	Modern Neuroscience Tools (GE, IM, EL)

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.

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

Subject	Catalog Number	Title
BME	520L	Computational Foundations of Biomedical Simulation (GE, BB, MC)

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.

BME526 - Elasticity (GE, BB)

Subject	Catalog Number	Title
BME	526	Elasticity (GE, BB)

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.

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

Subject	Catalog Number	Title
BME	524	Nanotechnology in Medicine (GE, BB, MC)

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.

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

Subject	Catalog Number	Title
BME	527	Cell Mechanics and Mechanotransduction (GE, BB, MC)

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.

BME528 - Biofluid Mechanics (GE, BB, MC)

Subject	Catalog Number	Title
BME	528	Biofluid Mechanics (GE, BB, MC)

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.

BME529 - Properties and Characterization of Polymeric Materials

Subject	Catalog Number	Title
BME	529	Properties and Characterization of Polymeric Materials

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.

BME530 - Introduction to Tissue Biomechanics (GE, BB)

Subject	Catalog Number	Title
BME	530	Introduction to Tissue Biomechanics (GE, BB)

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.

BME531 - Intermediate Biomechanics (GE, BB)

Subject	Catalog Number	Title
BME	531	Intermediate Biomechanics (GE, BB)

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.

BME532 - Viscoelastic Biomechanics (GE, BB)

Subject	Catalog Number	Title
BME	532	Viscoelastic Biomechanics (GE, BB)

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).

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

Subject	Catalog Number	Title
BME	535	Biomedical Aspects of Blast and Ballistics (GE, BB)

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.

BME540 - Mobile Devices for Biomedicine(GE, IM)

Subject	Catalog Number	Title
BME	540	Mobile Devices for Biomedicine(GE, IM)

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)

BME542 - Principles of Ultrasound Imaging (GE, IM)

Subject	Catalog Number	Title
BME	542	Principles of Ultrasound Imaging (GE, IM)

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.

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

Subject	Catalog Number	Title
BME	543L	Cardiac Ultrasound Imaging and Function (GE, IM)

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.

BME544 - Digital Image Processing (GE, IM)

Subject	Catalog Number	Title
BME	544	Digital Image Processing (GE, IM)

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.

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

Subject	Catalog Number	Title
BME	546	Magnetic Resonance Imaging: Physical Principles and Sequence Design (GE, IM)

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.

BME547 - Medical Software Design (GE, IM)

Subject	Catalog Number	Title
BME	547	Medical Software Design (GE, IM)

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.

BME548L - Machine Learning and Imaging (GE, IM)

Subject	Catalog Number	Title
BME	548L	Machine Learning and Imaging (GE, IM)

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.

BME550 - Modern Microscopy (GE, IM)

Subject	Catalog Number	Title
BME	550	Modern Microscopy (GE, IM)

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.

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

Subject	Catalog Number	Title
BME	551L	Biomedical Optical Spectroscopy and Tissue Optics (GE, IM)

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.

BME552 - Advanced Optics

Subject	Catalog Number	Title
BME	552	Advanced Optics

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.

BME553 - Deep Tissue Optics (GE, IM)

Subject	Catalog Number	Title
BME	553	Deep Tissue Optics (GE, IM)

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)

BME562 - Biology by Design (GE, MC)

Subject	Catalog Number	Title
BME	562	Biology by Design (GE, MC)

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.

BME555 - Advances in Photonics (GE, IM)

Subject	Catalog Number	Title
BME	555	Advances in Photonics (GE, IM)

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.

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

Subject	Catalog Number	Title
BME	563	Transport Processes in HIV Transmission and Prevention (GE, BB, MC)

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 (intra-vaginal 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.

BME564L - Genome Engineering Lab (GE, MC)

Subject	Catalog Number	Title
BME	564L	Genome Engineering Lab (GE, MC)

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)

BME565L - Environmental Molecular Biotechnology (GE, MC)

Subject	Catalog Number	Title
BME	565L	Environmental Molecular Biotechnology (GE, MC)

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.

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

Subject	Catalog Number	Title
BME	566	Transport Phenomena in Cells and Organs (GE, MC)

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.

BME567 - Biosensors (GE, IM, MC)

Subject	Catalog Number	Title
BME	567	Biosensors (GE, IM, MC)

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 nanoprobe, 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.

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

Subject	Catalog Number	Title
BME	570L	Introduction to Biomolecular Engineering (GE, BB, MC)

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.

BME577 - Drug Delivery (GE, BB, MC)

Subject	Catalog Number	Title
BME	577	Drug Delivery (GE, BB, MC)

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.

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

Subject	Catalog Number	Title
BME	574	Modeling and Engineering Gene Circuits (GE, MC)

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.

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

Subject	Catalog Number	Title
BME	578	Quantitative Cell and Tissue Engineering (GE, BB, MC)

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.

BME580 - An Introduction to Biomedical Data Science (GE)

Subject	Catalog Number	Title
BME	580	An Introduction to Biomedical Data Science (GE)

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)

BME590 - Special Topics in Biomedical Engineering

Subject	Catalog Number	Title
BME	590	Special Topics in Biomedical Engineering

Description

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

BME590D - Special Topics with Discussion

Subject	Catalog Number	Title
BME	590D	Special Topics with Discussion

Description

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

BME590DL - Special Topics with Lab and Discussion

Subject	Catalog Number	Title
BME	590DL	Special Topics with Lab and Discussion

Description

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

BME590L - Special Topics with Lab

Subject	Catalog Number	Title
BME	590L	Special Topics with Lab

Description

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

BME590L-1 - Special Topics with Lab

Subject	Catalog Number	Title
BME	590L-1	Special Topics with Lab

Description

Half-credit special topics course.

BME601L - Introduction to Neural Engineering

Subject	Catalog Number	Title
BME	601L	Introduction to Neural Engineering

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.

BME609 - Optics and Photonics Seminar Series

Subject	Catalog Number	Title
BME	609	Optics and Photonics Seminar Series

Description

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

BME644 - Physiology for Engineers

Subject	Catalog Number	Title
BME	644	Physiology for Engineers

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.

BME671L - Signal Processing and Applied Mathematics

Subject	Catalog Number	Title
BME	671L	Signal Processing and Applied Mathematics

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.

BME673L - Advanced Design and Manufacturing (GE, AE)

Subject	Catalog Number	Title
BME	673L	Advanced Design and Manufacturing (GE, AE)

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.

BME690 - Advanced Topics in Biomedical Engineering

Subject	Catalog Number	Title
BME	690	Advanced Topics in Biomedical Engineering

Description

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

BME701S - BME Graduate Seminars

Subject	Catalog Number	Title
BME	701S	BME Graduate Seminars

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 will 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.

BME702S - BME Graduate Seminars

Subject	Catalog Number	Title
BME	702S	BME Graduate Seminars

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.

BME705L - Biotech Design I

Subject	Catalog Number	Title
BME	705L	Biotech Design I

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.

BME706L - Biotech Design II

Subject	Catalog Number	Title
BME	706L	Biotech Design II

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.

BME711S - Biological Engineering Seminar Series (CBIMMS and CBTE)

Subject	Catalog Number	Title
BME	711S	Biological Engineering Seminar Series (CBIMMS and CBTE)

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.

BME712S - Biological Engineering Seminar Series (CBIMMS and CBTE)

Subject	Catalog Number	Title
BME	712S	Biological Engineering Seminar Series (CBIMMS and CBTE)

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.

BME713S - QBio Seminar Series

Subject	Catalog Number	Title
BME	713S	QBio Seminar Series

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.

BME728S - Teaching Seminar for New Teaching Assistants

Subject	Catalog Number	Title
BME	728S	Teaching Seminar for New Teaching Assistants

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.

BME729S - Teaching Seminar for Repeat Teaching Assistants

Subject	Catalog Number	Title
BME	729S	Teaching Seminar for Repeat Teaching Assistants

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.

BME733 - Experimental Design and Biostatistics for Basic Biomedical Scientists

Subject	Catalog Number	Title
BME	733	Experimental Design and Biostatistics for Basic Biomedical Scientists

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.

BME760L - Medical Neuroscience and Clinical Human Neuroanatomy

Subject	Catalog Number	Title
BME	760L	Medical Neuroscience and Clinical Human Neuroanatomy

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.

BME771 - Bioconjugation in drug biomaterials and drug delivery systems

Subject	Catalog Number	Title
BME	771	Bioconjugation in drug biomaterials and drug delivery systems

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.

BME773L - Design Health 1: Discover

Subject	Catalog Number	Title
BME	773L	Design Health 1: Discover

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.

BME774L - Design Health 2: Design

Subject	Catalog Number	Title
BME	774L	Design Health 2: Design

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

BME775L - Design Health 3: Deliver

Subject	Catalog Number	Title
BME	775L	Design Health 3: Deliver

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.

BME788 - Invention to Application: Healthcare Research Commercialization

Subject	Catalog Number	Title
BME	788	Invention to Application: Healthcare Research Commercialization

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.

BME789 - Internship in Biomedical Engineering

Subject	Catalog Number	Title
BME	789	Internship in Biomedical Engineering

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.

BME790 - Advanced Topics for Graduate Students in Biomedical Engineering

Subject	Catalog Number	Title
BME	790	Advanced Topics for Graduate Students in Biomedical Engineering

Description

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

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

Subject	Catalog Number	Title
BME	790L	Advanced Topics with the Lab for Graduate Students in Biomedical Engineering

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.

BME791 - Graduate Independent Study

Subject	Catalog Number	Title
BME	791	Graduate Independent Study

Description

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

BME792 - Continuation of Graduate Independent Study

Subject	Catalog Number	Title
BME	792	Continuation of Graduate Independent Study

Description

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

BME803 - Advanced Computational Neuroengineering

Subject	Catalog Number	Title
BME	803	Advanced Computational Neuroengineering

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.

BME804 - Developments in Neural Engineering

Subject	Catalog Number	Title
BME	804	Developments in Neural Engineering

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.

BME844 - Advanced Ultrasonic Imaging

Subject	Catalog Number	Title
BME	844	Advanced Ultrasonic Imaging

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.

BME845 - Elasticity Imaging

Subject	Catalog Number	Title
BME	845	Elasticity Imaging

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.

BME848L - Radiology in Practice

Subject	Catalog Number	Title
BME	848L	Radiology in Practice

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.

BME890 - Advanced topics for PhD students

Subject	Catalog Number	Title
BME	890	Advanced topics for PhD students

Description

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

BME899 - Special Readings in Biomedical Engineering

Subject	Catalog Number	Title
BME	899	Special Readings in Biomedical Engineering

Description

Individual readings in advanced study and research areas of biomedical engineering. Approval of director of graduate studies required.

CEE506 - Environmental Spatial Data Analysis

Subject	Catalog Number	Title
CEE	506	Environmental Spatial Data Analysis

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.

CEE511 - Construction Management

Subject	Catalog Number	Title
CEE	511	Construction Management

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.

CEE520 - Continuum Mechanics

Subject	Catalog Number	Title
CEE	520	Continuum Mechanics

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.

CEE521 - Elasticity (GE, BB)

Subject	Catalog Number	Title
CEE	521	Elasticity (GE, BB)

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.

CEE525 - Wave Propagation in Elastic and Poroelastic Media

Subject	Catalog Number	Title
CEE	525	Wave Propagation in Elastic and Poroelastic Media

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.

CEE530 - Introduction to the Finite Element Method

Subject	Catalog Number	Title
CEE	530	Introduction to the Finite Element Method

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.

CEE531 - Finite Element Methods for Problems in Fluid Mechanics

Subject	Catalog Number	Title
CEE	531	Finite Element Methods for Problems in Fluid Mechanics

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.

CEE541 - Structural Dynamics

Subject	Catalog Number	Title
CEE	541	Structural Dynamics

Description

Formulation of dynamic models for discrete and continuous structures; normal mode analysis, deterministic and stochastic responses to shocks and environmental loading (earthquakes, winds, and waves); introduction to nonlinear dynamic systems, analysis and stability of structural components (beams and cables and large systems such as offshore towers, moored ships, and floating platforms).

CEE560 - Environmental Transport Phenomena

Subject	Catalog Number	Title
CEE	560	Environmental Transport Phenomena

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.

CEE562L - Applied Biological Principles and Processes in Environmental Engineering

Subject	Catalog Number	Title
CEE	562L	Applied Biological Principles and Processes in Environmental Engineering

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.

CEE561L - Environmental Aquatic Chemistry

Subject	Catalog Number	Title
CEE	561L	Environmental Aquatic Chemistry

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.

CEE563 - Chemical Fate of Organic Compounds

Subject	Catalog Number	Title
CEE	563	Chemical Fate of Organic Compounds

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.

CEE563D - Chemical Fate of Organic Compounds

Subject	Catalog Number	Title
CEE	563D	Chemical Fate of Organic Compounds

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.

CEE564 - Physical Chemical Processes in Environmental Engineering

Subject	Catalog Number	Title
CEE	564	Physical Chemical Processes in Environmental Engineering

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.

CEE565 - Environmental Analytical Chemistry

Subject	Catalog Number	Title
CEE	565	Environmental Analytical Chemistry

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.

CEE566 - Environmental Microbiology

Subject	Catalog Number	Title
CEE	566	Environmental Microbiology

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.

CEE574 - Remote Sensing in Coastal Environments

Subject	Catalog Number	Title
CEE	574	Remote Sensing in Coastal Environments

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.

CEE575 - Air Pollution Engineering

Subject	Catalog Number	Title
CEE	575	Air Pollution Engineering

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.

CEE581 - Pollutant Transport Systems

Subject	Catalog Number	Title
CEE	581	Pollutant Transport Systems

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.

CEE584 - Physical Hydrology

Subject	Catalog Number	Title
CEE	584	Physical Hydrology

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.

CEE621 - Plasticity

Subject	Catalog Number	Title
CEE	621	Plasticity

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.

CEE622 - Fracture Mechanics

Subject	Catalog Number	Title
CEE	622	Fracture Mechanics

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.

CEE625 - Intermediate Dynamics: Dynamics of Very High Dimensional Systems

Subject	Catalog Number	Title
CEE	625	Intermediate Dynamics: Dynamics of Very High Dimensional Systems

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.

CEE627 - Linear System Theory

Subject	Catalog Number	Title
CEE	627	Linear System Theory

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 Mechanical Engineering 344, or consent of instructor.

CEE626 - Energy Flow and Wave Propagation in Elastic Solids

Subject	Catalog Number	Title
CEE	626	Energy Flow and Wave Propagation in Elastic Solids

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 (dilatational, 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.

CEE628 - Uncertainty Quantification in Computational Science and Engineering

Subject	Catalog Number	Title
CEE	628	Uncertainty Quantification in Computational Science and Engineering

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.

CEE629 - System Identification

Subject	Catalog Number	Title
CEE	629	System Identification

Description

Numerical linear algebra for modeling and filtering data (FFT, SVD, QR, and PCA); ordinary least squares, total least squares, and recursive least squares; measurement noise and propagation of measurement error; regularization; optimal linear filtering; state-space models, eigensystem realization, deterministic and stochastic subspace identification through projections and canonical correlation. Applications drawn from engineering, natural sciences, and finance.

CEE630 - Nonlinear Finite Element Analysis

Subject	Catalog Number	Title
CEE	630	Nonlinear Finite Element Analysis

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.

CEE642 - Environmental Geomechanics

Subject	Catalog Number	Title
CEE	642	Environmental Geomechanics

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.

CEE643 - Environmental and Engineering Geophysics

Subject	Catalog Number	Title
CEE	643	Environmental and Engineering Geophysics

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.

CEE647 - Buckling of Engineering Structures

Subject	Catalog Number	Title
CEE	647	Buckling of Engineering Structures

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.

CEE649 - Structural Engineering Project Management

Subject	Catalog Number	Title
CEE	649	Structural Engineering Project Management

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.

CEE661L - Environmental Molecular Biotechnology (GE, MC)

Subject	Catalog Number	Title
CEE	661L	Environmental Molecular Biotechnology (GE, MC)

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.

CEE666 - Aquatic Geochemistry

Subject	Catalog Number	Title
CEE	666	Aquatic Geochemistry

Description

Geochemistry of the water-solid interface of soils, minerals, and particles in earth systems. Topics will cover the chemical composition of soils, geochemical speciation, 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.

CEE667 - Chemical Transformation of Environmental Contaminants

Subject	Catalog Number	Title
CEE	667	Chemical Transformation of Environmental Contaminants

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.

CEE675 - Introduction to the Physical Principles of Remote Sensing of the Environment

Subject	Catalog Number	Title
CEE	675	Introduction to the Physical Principles of Remote Sensing of the Environment

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.

CEE679 - Environmental Engineering Project Management

Subject	Catalog Number	Title
CEE	679	Environmental Engineering Project Management

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.

CEE683 - Groundwater Hydrology and Contaminant Transport

Subject	Catalog Number	Title
CEE	683	Groundwater Hydrology and Contaminant Transport

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.

CEE684 - Physical Hydrology and Hydrometeorology

Subject	Catalog Number	Title
CEE	684	Physical Hydrology and Hydrometeorology

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.

CEE688 - Turbulence 1

Subject	Catalog Number	Title
CEE	688	Turbulence 1

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.

CEE690 - Advanced Topics in Civil and Environmental Engineering

Subject	Catalog Number	Title
CEE	690	Advanced Topics in Civil and Environmental Engineering

Description

A course on an advanced topic within the civil and environmental engineering department.

CEE691 - Independent Study: Advanced Topics in Civil and Environmental Engineering

Subject	Catalog Number	Title
CEE	691	Independent Study: Advanced Topics in Civil and Environmental Engineering

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.

CEE692 - Independent Study: Advanced Topics in Civil and Environmental Engineering

Subject	Catalog Number	Title
CEE	692	Independent Study: Advanced Topics in Civil and Environmental Engineering

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.

CEE702 - Graduate Colloquium

Subject	Catalog Number	Title
CEE	702	Graduate Colloquium

Description

Current topics in civil and environmental engineering theory and practice. Weekly seminar series.

CEE701 - Graduate Colloquium

Subject	Catalog Number	Title
CEE	701	Graduate Colloquium

Description

Current topics in civil and environmental engineering theory and practice. Weekly seminar series.

CEE761 - Hydrologic and Environmental Data Analysis

Subject	Catalog Number	Title
CEE	761	Hydrologic and Environmental Data Analysis

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.

CEE780 - Internship

Subject	Catalog Number	Title
CEE	780	Internship

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.

CEE890 - Advanced Topics in Civil & Environmental Engineering

Subject	Catalog Number	Title
CEE	890	Advanced Topics in Civil & Environmental Engineering

Description

A course on an advanced topic within the civil and environmental engineering department.

CEE891 - Independent Study: Advanced Topics in CEE

Subject	Catalog Number	Title
CEE	891	Independent Study: Advanced Topics in CEE

Description

Special individual readings in a specific area of study in civil and environmental engineering. Approval of director of graduate studies required.

CEE892 - Independent Study: Advanced Topics in CEE

Subject	Catalog Number	Title
CEE	892	Independent Study: Advanced Topics in CEE

Description

Special individual readings in a specific area of study in civil and environmental engineering. Approval of director of graduate studies required.

CYBERSEC500 - Introduction to Cybersecurity Perspectives

Subject	Catalog Number	Title
CYBERSEC	500	Introduction to Cybersecurity Perspectives

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.

CYBERSEC501 - Seminar

Subject	Catalog Number	Title
CYBERSEC	501	Seminar

Description

Current topics in applied cybersecurity. Weekly seminar series.

CYBERSEC502 - Cybersecurity and Interdisciplinary Law/Ethics/Policy/Privacy Considerations

Subject	Catalog Number	Title
CYBERSEC	502	Cybersecurity and Interdisciplinary Law/Ethics/Policy/Privacy Considerations

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.

CYBERSEC503 - Cybersecurity Risk Management

Subject	Catalog Number	Title
CYBERSEC	503	Cybersecurity Risk Management

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.

CYBERSEC504 - Introductory Residency

Subject	Catalog Number	Title
CYBERSEC	504	Introductory Residency

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.

CYBERSEC505 - Mid-Program Residency

Subject	Catalog Number	Title
CYBERSEC	505	Mid-Program Residency

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.

CYBERSEC506 - Concluding Residency

Subject	Catalog Number	Title
CYBERSEC	506	Concluding Residency

Description

One-week course to conclude the Master of Engineering Cybersecurity Online Program. Residency 3 includes internship presentations, team-building exercises, case studies, leadership training, professional development workshops, and exit interviews. Prerequisite: CYBERSEC 505. Open only to students in the Master of Engineering Cybersecurity Online Program.

CYBERSEC510 - Security Incident Detection, Response, and Resilience

Subject	Catalog Number	Title
CYBERSEC	510	Security Incident Detection, Response, and Resilience

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.

CYBERSEC520 - Applying Machine Learning to Advance Cybersecurity

Subject	Catalog Number	Title
CYBERSEC	520	Applying Machine Learning to Advance Cybersecurity

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.

CYBERSEC521 - Cybersecurity Program Development, Operations & Analysis

Subject	Catalog Number	Title
CYBERSEC	521	Cybersecurity Program Development, Operations & Analysis

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.

CYBERSEC530 - Identity and Access Management

Subject	Catalog Number	Title
CYBERSEC	530	Identity and Access Management

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.

CYBERSEC531 - The Human Element in Cybersecurity

Subject	Catalog Number	Title
CYBERSEC	531	The Human Element in Cybersecurity

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.

CYBERSEC535 - Secure Software Development

Subject	Catalog Number	Title
CYBERSEC	535	Secure Software Development

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.

CYBERSEC590 - Advanced Topics in Cybersecurity

Subject	Catalog Number	Title
CYBERSEC	590	Advanced Topics in Cybersecurity

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.

CYBERSEC590L - Advanced Topics in Cybersecurity with Lab

Subject	Catalog Number	Title
CYBERSEC	590L	Advanced Topics in Cybersecurity with Lab

Description

Opportunity for study of advanced subjects with laboratory related to programs within cybersecurity tailored to fit the requirements of a small group. Instructor consent required.

CYBERSEC591 - Special Readings in Cybersecurity

Subject	Catalog Number	Title
CYBERSEC	591	Special Readings in Cybersecurity

Description

Individual readings in advanced study and research areas of cybersecurity. Consent of instructor required.

ECE511 - Foundations of Nanoscale Science and Technology

Subject	Catalog Number	Title
ECE	511	Foundations of Nanoscale Science and Technology

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.

ECE512 - Emerging Nanoelectronic Devices

Subject	Catalog Number	Title
ECE	512	Emerging Nanoelectronic Devices

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.

ECE520 - Graduate Introduction to Quantum Engineering

Subject	Catalog Number	Title
ECE	520	Graduate Introduction to Quantum Engineering

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.

ECE521 - Quantum Mechanics

Subject	Catalog Number	Title
ECE	521	Quantum Mechanics

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.

ECE523 - Quantum Computing

Subject	Catalog Number	Title
ECE	523	Quantum Computing

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.

ECE524 - Introduction to Solid-State Physics

Subject	Catalog Number	Title
ECE	524	Introduction to Solid-State Physics

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.

ECE526 - Semiconductor Devices for Integrated Circuits

Subject	Catalog Number	Title
ECE	526	Semiconductor Devices for Integrated Circuits

Description

Basic semiconductor properties (energy-band structure, effective density of states, effective masses, carrier statistics, and carrier concentrations). Electron and hole behavior in semiconductors (generation, recombination, drift, diffusion, tunneling, and basic semiconductor equations). Current-voltage, capacitance-voltage, and static and dynamic models of PN Junctions, Schottky barriers, Metal/Semiconductor Contacts, Bipolar-Junction Transistors, MOS Capacitors, MOS-Gated Diodes, and MOS Field-Effect Transistors. SPICE models and model parameters. Prerequisites: Electrical and Computer Engineering 330L.

ECE528 - Nanoscale IC Chip Technology

Subject	Catalog Number	Title
ECE	528	Nanoscale IC Chip Technology

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.

ECE529 - Digital Integrated Circuits

Subject	Catalog Number	Title
ECE	529	Digital Integrated Circuits

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.

ECE531 - Power Electronic Circuits for Energy Conversion

Subject	Catalog Number	Title
ECE	531	Power Electronic Circuits for Energy Conversion

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.

ECE532 - Analog Integrated Circuit Design

Subject	Catalog Number	Title
ECE	532	Analog Integrated Circuit Design

Description

Design and layout of CMOS analog integrated circuits. Qualitative review of the theory of pn junctions, bipolar and MOS devices, and large and small signal models. Emphasis on MOS technology. Continuous time operational amplifiers. Frequency response, stability and compensation. Complex analog subsystems including phase-locked loops, A/D and D/A converters, switched capacitor simulation, layout, extraction, verification, and MATLAB modeling. Projects make extensive use of full custom VLSI CAD software. Prerequisite: [(ECE 330L or 331L) and ECE 230L and 250D and 270DL and 280L and (Mathematics 353 or 356) and (Statistical Science 130L or Mathematics 230 or ECE 555 or ECE 380 or Statistical Science 240L or EGR 238L or Mathematics 340) and (Physics 152L or 26) and (Chemistry 101DL or 20 or 21)] or graduate-student standing.

ECE533 - Biochip Engineering

Subject	Catalog Number	Title
ECE	533	Biochip Engineering

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).

ECE534 - Graduate Rainforest Engineering

Subject	Catalog Number	Title
ECE	534	Graduate Rainforest Engineering

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.

ECE539 - CMOS VLSI Design Methodologies

Subject	Catalog Number	Title
ECE	539	CMOS VLSI Design Methodologies

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 (Mathematics 353 or 356) and (Statistical Science 130L or Statistical Science 240L or Mathematics 230 or Mathematics 340 or ECE 380 or ECE 555 or EGR 238L) and (Physics 152L or 26) and (Chemistry 101DL or 20 or 21)] or graduate-student standing.

ECE538 - VLSI System Testing

Subject	Catalog Number	Title
ECE	538	VLSI System Testing

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.

ECE541 - Advanced Optics

Subject	Catalog Number	Title
ECE	541	Advanced Optics

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.

ECE542 - Holography and Coherent Imaging

Subject	Catalog Number	Title
ECE	542	Holography and Coherent Imaging

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.

ECE545 - Foundations of Nanoelectronics & Nanophotonics

Subject	Catalog Number	Title
ECE	545	Foundations of Nanoelectronics & Nanophotonics

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.

ECE543 - Statistical Optics

Subject	Catalog Number	Title
ECE	543	Statistical Optics

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.

ECE546 - Optoelectronic Devices

Subject	Catalog Number	Title
ECE	546	Optoelectronic Devices

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.

ECE549 - Optics and Photonics Seminar Series

Subject	Catalog Number	Title
ECE	549	Optics and Photonics Seminar Series

Description

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

ECE550D - Fundamentals of Computer Systems and Engineering

Subject	Catalog Number	Title
ECE	550D	Fundamentals of Computer Systems and Engineering

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. Corequisite: ECE 551D.

ECE550K - Fundamentals of Computer Systems and Engineering

Subject	Catalog Number	Title
ECE	550K	Fundamentals of Computer Systems and Engineering

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.

ECE551D - Programming, Data Structures, and Algorithms in C++

Subject	Catalog Number	Title
ECE	551D	Programming, Data Structures, and Algorithms in C++

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.

ECE551K - Programming, Data Structures, and Algorithms in C++

Subject	Catalog Number	Title
ECE	551K	Programming, Data Structures, and Algorithms in C++

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.

ECE553 - Compiler Construction

Subject	Catalog Number	Title
ECE	553	Compiler Construction

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).

ECE552 - Advanced Computer Architecture I

Subject	Catalog Number	Title
ECE	552	Advanced Computer Architecture I

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.

ECE554 - Fault-Tolerant and Testable Computer Systems

Subject	Catalog Number	Title
ECE	554	Fault-Tolerant and Testable Computer Systems

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.

ECE555 - Probability for Electrical and Computer Engineers

Subject	Catalog Number	Title
ECE	555	Probability for Electrical and Computer Engineers

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.

ECE556 - Wireless Networking and Mobile Computing

Subject	Catalog Number	Title
ECE	556	Wireless Networking and Mobile Computing

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.

ECE558 - Advanced Computer Networks

Subject	Catalog Number	Title
ECE	558	Advanced Computer Networks

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.

ECE559 - Advanced Digital System Design

Subject	Catalog Number	Title
ECE	559	Advanced Digital System Design

Description

Fundamentals of 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. Team-based project incorporates engineering standards and realistic constraints, and also considers most of the following: Cost, environmental impact, manufacturability, health and safety, ethics, social and political impact. Prerequisite: [ECE 350L, 230L, 250D, 270DL, and 280L and (Mathematics 353 or 356) and (Statistical Science 130L or Statistical Science 240L or Mathematics 230 or Mathematics 340 or ECE 380 or ECE 555 or EGR 238L) and (Physics 152L or 26) and (Chemistry 101DL or 20 or 21) and ECE 331L (prerequisite or corequisite)] or graduate-student standing.

ECE560 - Computer and Information Security

Subject	Catalog Number	Title
ECE	560	Computer and Information Security

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.

ECE563 - Cloud Computing

Subject	Catalog Number	Title
ECE	563	Cloud Computing

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.

ECE561 - Datacenter Architecture

Subject	Catalog Number	Title
ECE	561	Datacenter Architecture

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.

ECE564 - Mobile Application Development

Subject	Catalog Number	Title
ECE	564	Mobile Application Development

Description

Explores the world of mobile application development with focus on needs of engineers. Centered on Apple environment, with the development environment being on OS X and the target environment being an iOS device- iPad, iPhone, iPod Touch or Apple Watch. Real world context focused on the common programming patterns for engineers in academia or business- standalone apps, apps connected to other systems, apps connected to the cloud. Covers fundamentals essential to understanding all aspects of app development. Taught in a team environment. Students required to present their project proposals and deliver an app as a final project. Prerequisite: CompSci 307D or CompSci 308 or ECE 651.

ECE565 - Performance Optimization & Parallelism

Subject	Catalog Number	Title
ECE	565	Performance Optimization & Parallelism

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).

ECE567 - Cyber-Physical System Design

Subject	Catalog Number	Title
ECE	567	Cyber-Physical System Design

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.

ECE566 - Enterprise Storage Architecture

Subject	Catalog Number	Title
ECE	566	Enterprise Storage Architecture

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.

ECE568 - Engineering Robust Server Software

Subject	Catalog Number	Title
ECE	568	Engineering Robust Server Software

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)].

ECE571 - Electromagnetic Theory

Subject	Catalog Number	Title
ECE	571	Electromagnetic Theory

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.

ECE572 - Electromagnetic Communication Systems

Subject	Catalog Number	Title
ECE	572	Electromagnetic Communication Systems

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.

ECE573 - Optical Communication Systems

Subject	Catalog Number	Title
ECE	573	Optical Communication Systems

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.

ECE574 - Waves in Matter

Subject	Catalog Number	Title
ECE	574	Waves in Matter

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.

ECE575 - Microwave Electronic Circuits

Subject	Catalog Number	Title
ECE	575	Microwave Electronic Circuits

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.

ECE577 - Computational Electromagnetics

Subject	Catalog Number	Title
ECE	577	Computational Electromagnetics

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.

ECE580 - Introduction to Machine Learning

Subject	Catalog Number	Title
ECE	580	Introduction to Machine Learning

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.

ECE580K - Introduction to Machine Learning

Subject	Catalog Number	Title
ECE	580K	Introduction to Machine Learning

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.

ECE581 - Random Signals and Noise

Subject	Catalog Number	Title
ECE	581	Random Signals and Noise

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 Mathematics 340 or ECE 380 or ECE 555 or EGR 238L) or graduate student standing.

ECE581K - Random Signals and Noise

Subject	Catalog Number	Title
ECE	581K	Random Signals and Noise

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.

ECE582 - Digital Signal Processing

Subject	Catalog Number	Title
ECE	582	Digital Signal Processing

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 Wiener 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.

ECE583 - Data Science

Subject	Catalog Number	Title
ECE	583	Data Science

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 Science 216 or 316).

ECE585 - Signal Detection and Extraction Theory

Subject	Catalog Number	Title
ECE	585	Signal Detection and Extraction Theory

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.

ECE586D - Vector Space Methods with Applications

Subject	Catalog Number	Title
ECE	586D	Vector Space Methods with Applications

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.

ECE586K - Vector Space Methods with Applications

Subject	Catalog Number	Title
ECE	586K	Vector Space Methods with Applications

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.

ECE587 - Information Theory

Subject	Catalog Number	Title
ECE	587	Information Theory

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.

ECE588 - Image and Video Processing: From Mars to Hollywood with a Stop at the Hospital

Subject	Catalog Number	Title
ECE	588	Image and Video Processing: From Mars to Hollywood with a Stop at the Hospital

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.

ECE590 - Advanced Topics in Electrical and Computer Engineering

Subject	Catalog Number	Title
ECE	590	Advanced Topics in Electrical and Computer Engineering

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.

ECE590-1 - Advanced Topics in Electrical and Computer Engineering

Subject	Catalog Number	Title
ECE	590-1	Advanced Topics in Electrical and Computer Engineering

Description

Opportunity for study of advanced subjects in electrical and computer engineering.

ECE590D - Advanced Topics in Electrical and Computer Engineering

Subject	Catalog Number	Title
ECE	590D	Advanced Topics in Electrical and Computer Engineering

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.

ECE590K - Advanced Topics in Electrical and Computer Engineering

Subject	Catalog Number	Title
ECE	590K	Advanced Topics in Electrical and Computer Engineering

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.

ECE621 - Quantum Error Correction

Subject	Catalog Number	Title
ECE	621	Quantum Error Correction

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.

ECE623 - Quantum Information Theory

Subject	Catalog Number	Title
ECE	623	Quantum Information Theory

Description

This course introduces fundamental ideas of Quantum Information theory, such as entanglement, quantum entropy and mutual information, decoherence and quantum data compression. A primary goal of this field is to understand how quantum effects, such as entanglement, can enhance communication and cryptography protocols. Furthermore, the tools and ideas discussed in this course are essential for understanding and quantifying noise and decoherence in quantum computers. These concepts have also found various applications in different areas of Physics, including quantum thermodynamics, many-body systems and quantum gravity. Prerequisite: ECE 521, ECE 586, PHYSICS 464, MATH 216, MATH 218D-1, MATH 218D-2, or MATH 221.

ECE624 - Open Quantum Systems

Subject	Catalog Number	Title
ECE	624	Open Quantum Systems

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

ECE631 - Analog and RF Integrated Circuit Design, Fabrication, and Test

Subject	Catalog Number	Title
ECE	631	Analog and RF Integrated Circuit Design, Fabrication, and Test

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.

ECE650 - Systems Programming and Engineering

Subject	Catalog Number	Title
ECE	650	Systems Programming and Engineering

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).

ECE650K - Systems Programming and Engineering

Subject	Catalog Number	Title
ECE	650K	Systems Programming and Engineering

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.

ECE651 - Software Engineering

Subject	Catalog Number	Title
ECE	651	Software Engineering

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.

ECE651K - Software Engineering

Subject	Catalog Number	Title
ECE	651K	Software Engineering

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.

ECE652 - Advanced Computer Architecture II

Subject	Catalog Number	Title
ECE	652	Advanced Computer Architecture II

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.

ECE653 - Human-Centered Computing

Subject	Catalog Number	Title
ECE	653	Human-Centered Computing

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 reimagining on campus mental health management. Prerequisite: Computer Science 307D or 308 or Electrical and Computer Engineering 651.

ECE654 - Edge Computing

Subject	Catalog Number	Title
ECE	654	Edge Computing

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.

ECE656 - Cryptography

Subject	Catalog Number	Title
ECE	656	Cryptography

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.

ECE661 - Computer Engineering Machine Learning and Deep Neural Nets

Subject	Catalog Number	Title
ECE	661	Computer Engineering Machine Learning and Deep Neural Nets

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.

ECE662 - Machine Learning Acceleration and Neuromorphic Computing

Subject	Catalog Number	Title
ECE	662	Machine Learning Acceleration and Neuromorphic Computing

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.

ECE663 - Machine Learning in Adversarial Settings

Subject	Catalog Number	Title
ECE	663	Machine Learning in Adversarial Settings

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

ECE675 - Optical Imaging and Spectroscopy

Subject	Catalog Number	Title
ECE	675	Optical Imaging and Spectroscopy

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.

ECE681 - Pattern Classification and Recognition Technology

Subject	Catalog Number	Title
ECE	681	Pattern Classification and Recognition Technology

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.

ECE682D - Probabilistic Machine Learning

Subject	Catalog Number	Title
ECE	682D	Probabilistic Machine Learning

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.

ECE683 - Digital Communication Systems

Subject	Catalog Number	Title
ECE	683	Digital Communication Systems

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.

ECE684 - Natural Language Processing

Subject	Catalog Number	Title
ECE	684	Natural Language Processing

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.

ECE685D - Introduction to Deep Learning

Subject	Catalog Number	Title
ECE	685D	Introduction to Deep Learning

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.

ECE685K - Introduction to Deep Learning

Subject	Catalog Number	Title
ECE	685K	Introduction to Deep Learning

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.

ECE686 - Adaptive Filters

Subject	Catalog Number	Title
ECE	686	Adaptive Filters

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 transversal 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.

ECE687D - Theory and Algorithms for Machine Learning

Subject	Catalog Number	Title
ECE	687D	Theory and Algorithms for Machine Learning

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.

ECE688 - Sensor Array Signal Processing

Subject	Catalog Number	Title
ECE	688	Sensor Array Signal Processing

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.

ECE689 - Advanced Topics in Deep Learning

Subject	Catalog Number	Title
ECE	689	Advanced Topics in Deep Learning

Description

Focus on advanced topics in deep learning, particularly methodological methods. This includes discriminative models (e.g., infinite/infinesimal/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.

ECE701S - Being a Successful ECE Masters Student

Subject	Catalog Number	Title
ECE	701S	Being a Successful ECE Masters Student

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.

ECE721 - Nanotechnology Materials Lab

Subject	Catalog Number	Title
ECE	721	Nanotechnology Materials Lab

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.

ECE741 - Compressed Sensing and Related Topics

Subject	Catalog Number	Title
ECE	741	Compressed Sensing and Related Topics

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.

ECE722 - Quantum Electronics

Subject	Catalog Number	Title
ECE	722	Quantum Electronics

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.

ECE751D - Advanced Programming, Data Structures, and Algorithms in C++

Subject	Catalog Number	Title
ECE	751D	Advanced Programming, Data Structures, and Algorithms in C++

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.

ECE781 - Advanced Topics in Signal Processing

Subject	Catalog Number	Title
ECE	781	Advanced Topics in Signal Processing

ECE784LA - Sound in the Sea: Introduction to Marine Bioacoustics

Subject	Catalog Number	Title
ECE	784LA	Sound in the Sea: Introduction to Marine Bioacoustics

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.

ECE891 - Internship

Subject	Catalog Number	Title
ECE	891	Internship

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.

ECE899 - Special Readings in Electrical Engineering

Subject	Catalog Number	Title
ECE	899	Special Readings in Electrical Engineering

Description

Special individual readings in a specified area of study in electrical engineering. Approval of director of graduate studies required.

EGR505 - Oral Communication Skills for Engineers

Subject	Catalog Number	Title
EGR	505	Oral Communication Skills for Engineers

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.

EGR506 - Academic & Professional Writing for Engineers I

Subject	Catalog Number	Title
EGR	506	Academic & Professional Writing for Engineers I

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.

EGR590 - Special Topics in Engineering

Subject	Catalog Number	Title
EGR	590	Special Topics in Engineering

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.

EGR590-1 - Special Topics in Engineering

Subject	Catalog Number	Title
EGR	590-1	Special Topics in Engineering

Description

Subjects of an interdepartmental nature in engineering tailored for entry-level graduate students.

EGR705 - Academic Presentations for Engineers

Subject	Catalog Number	Title
EGR	705	Academic Presentations for Engineers

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.

EGR706 - Academic & Professional Writing for Engineers II

Subject	Catalog Number	Title
EGR	706	Academic & Professional Writing for Engineers II

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.

EGR790 - Special Topics in Engineering

Subject	Catalog Number	Title
EGR	790	Special Topics in Engineering

Description

General engineering topics intended for graduate students only, and interdepartmental in nature. Instructor consent is required.

EGR790-1 - Special Topics in Engineering

Subject	Catalog Number	Title
EGR	790-1	Special Topics in Engineering

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.

EGR790S - Special Topics in Engineering for Graduate Students

Subject	Catalog Number	Title
EGR	790S	Special Topics in Engineering for Graduate Students

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.

EGRMGMT501 - Engineering Management Seminar

Subject	Catalog Number	Title
EGRMGMT	501	Engineering Management Seminar

Description

Current topics in applied engineering management and entrepreneurship. Weekly seminar series. Credit/No credit.

EGRMGMT504 - Residency 1 - Introduction

Subject	Catalog Number	Title
EGRMGMT	504	Residency 1 - Introduction

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.

EGRMGMT505 - Residency 2 - Mid-Program

Subject	Catalog Number	Title
EGRMGMT	505	Residency 2 - Mid-Program

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.

EGRMGMT506 - Residency 3 - Conclusion and Graduation

Subject	Catalog Number	Title
EGRMGMT	506	Residency 3 - Conclusion and Graduation

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.

EGRMGMT510 - Marketing

Subject	Catalog Number	Title
EGRMGMT	510	Marketing

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.

EGRMGMT512 - Product Management in High-Tech Companies

Subject	Catalog Number	Title
EGRMGMT	512	Product Management in High-Tech Companies

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.

EGRMGMT514 - Negotiations and Consultative Selling in Technology

Subject	Catalog Number	Title
EGRMGMT	514	Negotiations and Consultative Selling in Technology

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.

EGRMGMT513 - Product Development

Subject	Catalog Number	Title
EGRMGMT	513	Product Development

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.

EGRMGMT520 - Intellectual Property, Business Law, and Entrepreneurship

Subject	Catalog Number	Title
EGRMGMT	520	Intellectual Property, Business Law, and Entrepreneurship

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.

EGRMGMT530 - Finance in High Tech Industries

Subject	Catalog Number	Title
EGRMGMT	530	Finance in High Tech Industries

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.

EGRMGMT532 - Advanced Corporate Finance for Technology-Based Companies

Subject	Catalog Number	Title
EGRMGMT	532	Advanced Corporate Finance for Technology-Based Companies

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.

EGRMGMT534 - Quantitative Financial Analysis for Technology-Driven Investment Decisions

Subject	Catalog Number	Title
EGRMGMT	534	Quantitative Financial Analysis for Technology-Driven Investment Decisions

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.

EGRMGMT540 - Management of High Tech Industries

Subject	Catalog Number	Title
EGRMGMT	540	Management of High Tech Industries

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.

EGRMGMT542 - Competitive Strategy in Technology-Based Industries

Subject	Catalog Number	Title
EGRMGMT	542	Competitive Strategy in Technology-Based Industries

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.

EGRMGMT550 - Engineering Management Internship

Subject	Catalog Number	Title
EGRMGMT	550	Engineering Management Internship

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.

EGRMGMT551 - Engineering Management Internship Assessment

Subject	Catalog Number	Title
EGRMGMT	551	Engineering Management Internship Assessment

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.

EGRMGMT552 - Engineering Management Supplemental Internship

Subject	Catalog Number	Title
EGRMGMT	552	Engineering Management Supplemental Internship

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.

EGRMGMT556 - Engineering Management Practicum

Subject	Catalog Number	Title
EGRMGMT	556	Engineering Management Practicum

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.

EGRMGMT562 - Operations Management

Subject	Catalog Number	Title
EGRMGMT	562	Operations Management

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.

EGRMGMT560 - Project Management

Subject	Catalog Number	Title
EGRMGMT	560	Project Management

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.

EGRMGMT563 - Supply Chain Management

Subject	Catalog Number	Title
EGRMGMT	563	Supply Chain Management

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.

EGRMGMT572 - Innovation Management in Technology-Based Organizations

Subject	Catalog Number	Title
EGRMGMT	572	Innovation Management in Technology-Based Organizations

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.

EGRMGMT575 - Software Quality Management

Subject	Catalog Number	Title
EGRMGMT	575	Software Quality Management

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.

EGRMGMT574 - Commercializing Technology Innovations: Turning Visions into Value

Subject	Catalog Number	Title
EGRMGMT	574	Commercializing Technology Innovations: Turning Visions into Value

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.

EGRMGMT576 - Design Thinking and Innovation

Subject	Catalog Number	Title
EGRMGMT	576	Design Thinking and Innovation

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.

EGRMGMT578 - Designing Customer Experiences in Technology

Subject	Catalog Number	Title
EGRMGMT	578	Designing Customer Experiences in Technology

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.

EGRMGMT580 - Decision Models

Subject	Catalog Number	Title
EGRMGMT	580	Decision Models

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 trees 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.

EGRMGMT579 - Using Real-Time Data to Improve Customer Quality Experience

Subject	Catalog Number	Title
EGRMGMT	579	Using Real-Time Data to Improve Customer Quality Experience

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.

EGRMGMT585 - Fundamentals of Data Science in Engineering Management

Subject	Catalog Number	Title
EGRMGMT	585	Fundamentals of Data Science in Engineering Management

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.

EGRMGMT586 - New Opportunities in Big Data

Subject	Catalog Number	Title
EGRMGMT	586	New Opportunities in Big Data

Description

This course prepares students for transitioning to industry data science practitioners by focusing on learning-by-doing. Students gain hands-on experience applying statistical and machine learning techniques using real world data and creating data science solutions through Python and other popular open source tools in the era of big data. In addition, the course covers lectures on a number of intermediate data science topics such as supervised learning, unsupervised learning, ensemble learning, model optimization, text analytics, and data visualization. Recommended prerequisite: at least one undergraduate level statistics course and prior programming experience (not necessarily in Python).

EGRMGMT587 - Data Visualization for Engineering Managers

Subject	Catalog Number	Title
EGRMGMT	587	Data Visualization for Engineering Managers

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.

EGRMGMT588 - Machine Learning Principles and Applications for Engineering Managers

Subject	Catalog Number	Title
EGRMGMT	588	Machine Learning Principles and Applications for Engineering Managers

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.

EGRMGMT590 - Advanced Topics in Engineering Management

Subject	Catalog Number	Title
EGRMGMT	590	Advanced Topics in Engineering Management

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.

EGRMGMT590L - Advanced Topics in Engineering Management (with Lab)

Subject	Catalog Number	Title
EGRMGMT	590L	Advanced Topics in Engineering Management (with Lab)

Description

Opportunity for study of advanced subjects with laboratory related to programs within engineering management tailored to fit the requirements of a small group. Permission of instructor required.

EGRMGMT591 - Special Readings in Engineering Management

Subject	Catalog Number	Title
EGRMGMT	591	Special Readings in Engineering Management

Description

Individual readings in advanced study and research areas of engineering management. Consent of instructor required.

ENRGYEGR531 - Power Electronic Circuits for Energy Conversion

Subject	Catalog Number	Title
ENRGYEGR	531	Power Electronic Circuits for Energy Conversion

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.

ENRGYEGR590 - Special Topics in Energy Engineering

Subject	Catalog Number	Title
ENRGYEGR	590	Special Topics in Energy Engineering

Description

Study arranged on a special topic in which the instructor has particular interest and competence. Topics vary by section.

FINTECH501 - Financial Technology Seminar

Subject	Catalog Number	Title
FINTECH	501	Financial Technology Seminar

Description

Current topics in applied financial technology and entrepreneurship. Weekly seminar series. Credit/No credit.

FINTECH502 - FinTech Capstone

Subject	Catalog Number	Title
FINTECH	502	FinTech Capstone

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.

FINTECH504 - Introductory Residency

Subject	Catalog Number	Title
FINTECH	504	Introductory Residency

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.

FINTECH505 - Mid-Program Residency

Subject	Catalog Number	Title
FINTECH	505	Mid-Program Residency

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.

FINTECH506 - Concluding Residency

Subject	Catalog Number	Title
FINTECH	506	Concluding Residency

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.

FINTECH510 - Programming for FinTech

Subject	Catalog Number	Title
FINTECH	510	Programming for FinTech

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.

FINTECH512 - Software Engineering for FinTech

Subject	Catalog Number	Title
FINTECH	512	Software Engineering for FinTech

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.

FINTECH514 - Secure Software Development

Subject	Catalog Number	Title
FINTECH	514	Secure Software Development

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.

FINTECH520 - Financial Institution Products & Services

Subject	Catalog Number	Title
FINTECH	520	Financial Institution Products & Services

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.

FINTECH522 - Asset Pricing and Risk Management

Subject	Catalog Number	Title
FINTECH	522	Asset Pricing and Risk Management

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.

FINTECH533 - Design and Testing of Algorithmic Trading Systems

Subject	Catalog Number	Title
FINTECH	533	Design and Testing of Algorithmic Trading Systems

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.

FINTECH534 - Quantitative Financial Analysis for Technology-Driven Investment Decisions

Subject	Catalog Number	Title
FINTECH	534	Quantitative Financial Analysis for Technology-Driven Investment Decisions

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.

FINTECH535 - Advanced Design and Testing of Algorithmic Trading Systems

Subject	Catalog Number	Title
FINTECH	535	Advanced Design and Testing of Algorithmic Trading Systems

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.

FINTECH536 - Robo-Advising: The Future of Investing?

Subject	Catalog Number	Title
FINTECH	536	Robo-Advising: The Future of Investing?

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.

FINTECH540 - Machine Learning for FinTech

Subject	Catalog Number	Title
FINTECH	540	Machine Learning for FinTech

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.

FINTECH545 - Quantitative Risk Management

Subject	Catalog Number	Title
FINTECH	545	Quantitative Risk Management

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.

FINTECH550 - Emerging Trends for FinTech

Subject	Catalog Number	Title
FINTECH	550	Emerging Trends for FinTech

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.

FINTECH552 - FinTech Business Models

Subject	Catalog Number	Title
FINTECH	552	FinTech Business Models

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.

FINTECH564 - Blockchain

Subject	Catalog Number	Title
FINTECH	564	Blockchain

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.

FINTECH565 - Advanced Blockchain - Smart Contracts and Solidity Coding

Subject	Catalog Number	Title
FINTECH	565	Advanced Blockchain - Smart Contracts and Solidity Coding

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.

FINTECH590 - Advanced Topics in Financial Technology

Subject	Catalog Number	Title
FINTECH	590	Advanced Topics in Financial Technology

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.

FINTECH590L - Advanced Topics in Financial Technology (with Lab)

Subject	Catalog Number	Title
FINTECH	590L	Advanced Topics in Financial Technology (with Lab)

Description

Opportunity for study of advanced subjects with laboratory related to programs within financial technology tailored to fit the requirements of a small group. Consent of instructor required.

FINTECH591 - Special Readings in Financial Technology

Subject	Catalog Number	Title
FINTECH	591	Special Readings in Financial Technology

Description

Individual readings in advanced study and research areas of financial technology. Consent of instructor required.

GAMEDSGN530 - Critical Analysis of Video Games

Subject	Catalog Number	Title
GAMEDSGN	530	Critical Analysis of Video Games

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.

ME510 - Diffraction and Spectrometry of Materials

Subject	Catalog Number	Title
ME	510	Diffraction and Spectrometry of Materials

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.

ME513 - Nanobiomechanics

Subject	Catalog Number	Title
ME	513	Nanobiomechanics

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.

ME511 - Computational Materials Science

Subject	Catalog Number	Title
ME	511	Computational Materials Science

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 Schrodinger'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.

ME514 - Properties and Characterization of Polymeric Materials

Subject	Catalog Number	Title
ME	514	Properties and Characterization of Polymeric Materials

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.

ME516 - Thin-Film Photovoltaic Technology

Subject	Catalog Number	Title
ME	516	Thin-Film Photovoltaic Technology

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.

ME524 - Introduction to the Finite Element Method

Subject	Catalog Number	Title
ME	524	Introduction to the Finite Element Method

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.

ME525 - Nonlinear Finite Element Analysis

Subject	Catalog Number	Title
ME	525	Nonlinear Finite Element Analysis

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.

ME527 - Buckling of Engineering Structures

Subject	Catalog Number	Title
ME	527	Buckling of Engineering Structures

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.

ME531 - Engineering Thermodynamics

Subject	Catalog Number	Title
ME	531	Engineering Thermodynamics

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.

ME535 - Biomedical Microsystems

Subject	Catalog Number	Title
ME	535	Biomedical Microsystems

Description

The 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.

ME532 - Convective Heat Transfer

Subject	Catalog Number	Title
ME	532	Convective Heat Transfer

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.

ME536 - Compressible Fluid Flow

Subject	Catalog Number	Title
ME	536	Compressible Fluid Flow

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.

ME538 - Physicochemical Hydrodynamics

Subject	Catalog Number	Title
ME	538	Physicochemical Hydrodynamics

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.

ME539 - Interfacial Transport Phenomena for Energy Technologies

Subject	Catalog Number	Title
ME	539	Interfacial Transport Phenomena for Energy Technologies

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.

ME541 - Intermediate Dynamics: Dynamics of Very High Dimensional Systems

Subject	Catalog Number	Title
ME	541	Intermediate Dynamics: Dynamics of Very High Dimensional Systems

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.

ME543 - Energy Flow and Wave Propagation in Elastic Solids

Subject	Catalog Number	Title
ME	543	Energy Flow and Wave Propagation in Elastic Solids

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 (dilatational, 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.

ME544 - Advanced Mechanical Vibrations

Subject	Catalog Number	Title
ME	544	Advanced Mechanical Vibrations

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.

ME555 - Advanced Topics in Mechanical Engineering

Subject	Catalog Number	Title
ME	555	Advanced Topics in Mechanical Engineering

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.

ME560S - Materials Science and Engineering Seminar

Subject	Catalog Number	Title
ME	560S	Materials Science and Engineering Seminar

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.

ME562 - Materials Synthesis and Processing

Subject	Catalog Number	Title
ME	562	Materials Synthesis and Processing

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.

ME571 - Aerodynamics

Subject	Catalog Number	Title
ME	571	Aerodynamics

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.

ME572 - Engineering Acoustics

Subject	Catalog Number	Title
ME	572	Engineering Acoustics

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.

ME582 - Applications in Data and Materials Science

Subject	Catalog Number	Title
ME	582	Applications in Data and Materials Science

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.

ME591 - Research Independent Study in Mechanical Engineering or Material Science

Subject	Catalog Number	Title
ME	591	Research Independent Study in Mechanical Engineering or Material Science

Description

Research project mentored by an instructor with related interests and expertise. The project is expected to be graduate-level work. Instructor consent required.

ME592 - Research Independent Study in Mechanical Engineering or Material Science

Subject	Catalog Number	Title
ME	592	Research Independent Study in Mechanical Engineering or Material Science

Description

Research project mentored by an instructor with related interests and expertise. The project is expected to be graduate-level work. Instructor consent required.

ME593 - Research Independent Study in Mechanical Engineering or Material Science

Subject	Catalog Number	Title
ME	593	Research Independent Study in Mechanical Engineering or Material Science

Description

Research project mentored by an instructor with related interests and expertise. The project is expected to be graduate-level work. Instructor consent required.

ME594 - Research Independent Study in Mechanical Engineering or Material Science

Subject	Catalog Number	Title
ME	594	Research Independent Study in Mechanical Engineering or Material Science

Description

Research project mentored by an instructor with related interests and expertise. The project is expected to be graduate-level work. Instructor consent required.

ME627 - Linear System Theory

Subject	Catalog Number	Title
ME	627	Linear System Theory

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 Mechanical Engineering 344, or consent of instructor.

ME631 - Intermediate Fluid Mechanics

Subject	Catalog Number	Title
ME	631	Intermediate Fluid Mechanics

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.

ME634 - Turbulence 1

Subject	Catalog Number	Title
ME	634	Turbulence 1

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.

ME639 - Computational Fluid Mechanics and Heat Transfer

Subject	Catalog Number	Title
ME	639	Computational Fluid Mechanics and Heat Transfer

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).

ME671 - Advanced Aerodynamics

Subject	Catalog Number	Title
ME	671	Advanced Aerodynamics

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.

ME672 - Unsteady Aerodynamics

Subject	Catalog Number	Title
ME	672	Unsteady Aerodynamics

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.

ME676 - Advanced Acoustics

Subject	Catalog Number	Title
ME	676	Advanced Acoustics

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.

ME711 - Nanotechnology Materials Lab

Subject	Catalog Number	Title
ME	711	Nanotechnology Materials Lab

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.

ME717S - Biological Engineering Seminar Series (CBIMMS and CBTE)

Subject	Catalog Number	Title
ME	717S	Biological Engineering Seminar Series (CBIMMS and CBTE)

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.

ME718S - Biological Engineering Seminar Series (CBIMMS and CBTE)

Subject	Catalog Number	Title
ME	718S	Biological Engineering Seminar Series (CBIMMS and CBTE)

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.

ME758S - Curricular Practical Training

Subject	Catalog Number	Title
ME	758S	Curricular Practical Training

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.

ME775 - Aeroelasticity

Subject	Catalog Number	Title
ME	775	Aeroelasticity

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.

ME742 - Nonlinear Mechanical Vibration

Subject	Catalog Number	Title
ME	742	Nonlinear Mechanical Vibration

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.

ME759 - Special Readings in Mechanical Engineering

Subject	Catalog Number	Title
ME	759	Special Readings in Mechanical Engineering

Description

Individual readings in advanced study and research areas of mechanical engineering. Approval of director of graduate studies required. 1 to 3 units.

ME789 - Internship in Mechanical Engineering

Subject	Catalog Number	Title
ME	789	Internship in Mechanical Engineering

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.

MENG540 - Management of High Tech Industries

Subject	Catalog Number	Title
MENG	540	Management of High Tech Industries

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.

MENG550 - Master of Engineering Internship/Project

Subject	Catalog Number	Title
MENG	550	Master of Engineering Internship/Project

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.

MENG549 - Career Preparation

Subject	Catalog Number	Title
MENG	549	Career Preparation

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 to 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.

MENG550K - Master of Engineering Internship/Project

Subject	Catalog Number	Title
MENG	550K	Master of Engineering Internship/Project

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.

MENG551 - Master of Engineering Internship/Project Assessment

Subject	Catalog Number	Title
MENG	551	Master of Engineering Internship/Project Assessment

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.

MENG552 - Master of Engineering Supplemental Internship

Subject	Catalog Number	Title
MENG	552	Master of Engineering Supplemental Internship

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.

MENG570 - Business Fundamentals for Engineers

Subject	Catalog Number	Title
MENG	570	Business Fundamentals for Engineers

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.