



Graduate programs in
BIOMEDICAL ENGINEERING



MARQUETTE
UNIVERSITY

Be The Difference.



Why graduate studies in Biomedical Engineering at Marquette?

Our department offers more than 30 graduate courses in support of our doctoral and master's programs. Those courses, in conjunction with courses offered by other departments at Marquette and the Medical College of Wisconsin, allow you to tailor a program to your needs and interests. Our faculty members have strong industry ties and are renowned for their research and teaching, which translates into outstanding networking opportunities for you. In addition, our program couples human physiology with advanced biomedical engineering to give you excellent interdisciplinary training.

ABOUT MARQUETTE

Our programs. Marquette offers 50 doctoral and master's degree and more than 30 graduate certificate programs, and a School of Dentistry and Law School. And we have a variety of specializations to help you tailor the curriculum to your needs — an opportunity not offered by all universities.

Our students. We enroll approximately 3,700 graduate and professional students from diverse cultural and educational backgrounds and 68 countries all over the world.

Our faculty. Marquette's almost 700 full-time faculty represent renowned scholars and industry experts. As a student, you'll also benefit from established collaborations within the local business and nonprofit communities, as well as other nationally renowned institutions within the region, including the Clinical and Translational Science Institute, Medical College of Wisconsin, Milwaukee School of Engineering, University of Wisconsin system, and others.

Our research. Graduate students can participate in important research alongside our renowned faculty members — making you a contributing member of our research team, not just a face in the crowd like at some other universities. Marquette's overall research award volume in fiscal year 2010 reached a record high, with faculty receiving more than \$28 million. Federal award dollars increased by 81 percent, and the average award size rose by 45 percent.

Our commitment. Class sizes are small and are usually taught by regular faculty members who are conducting cutting edge research. Your teaching will be informed by current research, and you will often have the opportunity to participate in research.

Our network. As a graduate of Marquette, you'll become part of our alumni family of 110,000 around the world — creating a professional network that spans from right next door to across the globe.

Our values-based education. As a Jesuit institution of higher education, Marquette continues a centuries-old tradition of academic excellence, development of the whole person and research that addresses societal needs.

Be opportunistic. The close and long-standing collaborative relationship between Marquette's Biomedical Engineering Department and surrounding medical institutions means a vast assortment of research opportunities and facilities.

Be cutting edge. Attend weekly graduate seminars hosted by the department and led by faculty from universities all over the world who are conducting groundbreaking research.

Be noticed. A small student-to-faculty ratio means faculty members take a real interest in your research and career goals.

Be connected. Our [faculty members'](#) strong industry ties, [advisory board](#) and more than 2,000 College of Engineering graduate program [alumni](#) mean outstanding networking possibilities.

Be supported. We offer [generous benefits](#) to qualified students every year in the form of research assistantships, teaching assistantships, tuition scholarships and fellowships. Assistantships include full tuition and a monthly stipend, as well as health care benefits.

Biomedical engineering graduate programs:

[Doctorate in biomedical engineering](#)

[Doctorate in functional imaging](#)

(offered jointly with the Medical College of Wisconsin)

[Master of science in biomedical engineering \(thesis option\)](#)

[Master of engineering in biomedical engineering](#)

YOUR JOURNEY

A growing focus on health issues, a demand for better and more sophisticated medical devices and equipment, and an increased concern for cost effectiveness mean excellent job prospects for you. Biomedical engineers are predicted to experience faster employment growth than the national average, increasing 72 percent in the next decade, according to the 2010-11 edition of the U.S. Bureau of Labor Statistics' *Occupational Handbook*. Many of these careers, particularly those in research laboratories, require a graduate degree, the handbook says. A degree from Marquette will prepare you for these demanding fields so you'll be ready to take advantage of the opportunities that come your way.

Doctorate

Specialization: bioinstrumentation/computers, biomechanics/biomaterials, functional imaging (joint program with the Medical College of Wisconsin), rehabilitation bioengineering and systems physiology

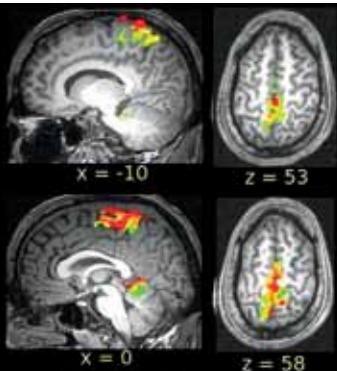
Research opportunities: orthopedics, human motion, neurorehabilitation, robotics, prosthetics, assistive technologies, neural engineering, sensory motor control, perceptual learning, functional magnetic resonance imaging, neuroimaging, modeling and computation, lung physiology, cardiovascular physiology, and computational fluid dynamics

Course work:

- Students must complete a minimum of 45 post-baccalaureate credit hours (15-16 classes), plus 12 dissertation credits, pass a doctoral-qualifying exam, and submit and successfully defend a dissertation.
- Full-time students typically enroll in nine credit hours (three classes) per semester to complete their degree work in four to five years and can expect to commit 27 hours per week to out-of-class course work and research obligations.
- Part-time students typically enroll in three to six credit hours (one to two classes) per semester.
- All programs include course work in engineering, biology, mathematics and medicine, all of which are incorporated with research laboratory experience.
- Course work must include a minimum of three credit hours (one class) of graduate-level physiology.
- All students must complete at least nine credit hours (three classes) of research methodologies and teaching methodologies courses.

Is our doctorate in functional imaging right for you?

Would you like to engage in research alongside renowned faculty using medical imaging and bioimaging technologies to investigate physiologic function on multiple scales, from cell to whole organ? Advances in the translation of functional imaging research to the clinic have led to more effective therapies for patients with brain tumors, stroke, epilepsy, Parkinson's disease and more. For more information, visit marquette.edu/imaging.



“The diverse research opportunities and rich collaboration with local institutions enabled me to pursue a research project in an area I am truly passionate about. Dedicated faculty constantly provide mentoring and guidance, while my participation in clinicals and a research assistantship allow me to apply theoretical knowledge and analytical skills to real-world applications.”

Dominic Nathan
Doctoral student

Dissertation and exam requirements:

- All students must complete and defend a dissertation representing an original research contribution.
- All students must pass a doctoral candidacy exam consisting of written and oral components.
- Students entering the program with a master's degree must complete the written portion of the exam within two terms.
- Students entering with a bachelor's degree must complete the written portion of the exam before or at completion of 30 graduate credit hours (10 classes) or completion of their master's degree.
- All students are required to complete the oral portion of the exam by the end of their third year. This is considered the public defense of a student's dissertation outline.
- All students must produce and successfully defend a dissertation. The public defense of the dissertation is conducted in the form of a department seminar.

Research and seminar opportunities:

- Course work for every student is suited to his or her individual research interests in conjunction with an adviser. Laboratory requirements are based on each student's customized plan.
- Many graduate students support undergraduate student laboratory experiences.
- Students are required to attend weekly departmental seminars.

For more program details, including requirements and course descriptions, see the *Graduate Bulletin* at marquette.edu/grad.

Master of science in biomedical engineering (thesis program)

Specializations: bioinstrumentation/computers, biomechanics/biomaterials, rehabilitation bioengineering and systems physiology

Course work:

- Students must complete 24 credit hours (typically eight classes) of course work, plus six hours of thesis work.
- Full-time students must take at least seven credit hours per semester.
- Full-time students typically enroll in nine credit hours (three classes) per semester to complete their degree work in one to two years and can expect to commit 27 hours per week to out-of-class course work and research obligations.
- All programs include course work in engineering, biology, mathematics and medicine, all of which are incorporated with research laboratory experience.

Thesis and comprehensive examination:

- All students must successfully complete an oral comprehensive exam and submit an approved thesis.

Research and seminar opportunities:

- Course work for every student is suited to his or her individual research interests in conjunction with an adviser. Laboratory requirements are based on each student's customized plan.
- Many research opportunities exist in on-campus faculty laboratories and nearby medical laboratories.
- Research and graduate assistants can spend time in the laboratory conducting or assisting with original research.
- Students are required to attend weekly departmental seminars.

For more program details, including requirements and course descriptions, see the *Graduate Bulletin* at marquette.edu/grad.

Master of engineering in biomedical engineering (course only)

Specializations: biocomputing, bioimaging, biomechanics, bioinstrumentation and biorehabilitation

Course work:

- Students must complete 30 credit hours (10 classes) of course work, including three credits of independent readings and research.
- Full-time students typically enroll in nine to 12 credit hours (three or four classes) per semester to complete their degree work in two years and can expect to commit 18 hours per week to out-of-class course work.
- Part-time students typically enroll in six credit hours (two classes) per semester.
- Students must complete an upper-level undergraduate human physiology course.
- All programs include course work in engineering, life sciences, mathematics, medicine and healthcare technologies management, all of which are integrated in a capstone comprehensive examination.

Comprehensive examination:

- All students must successfully complete a capstone comprehensive exam.

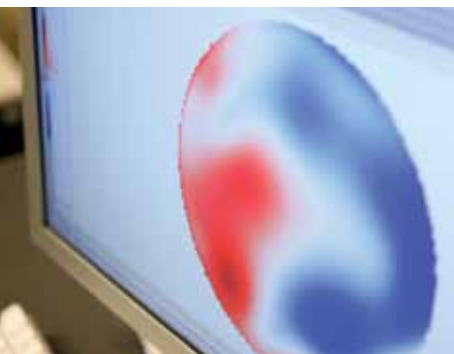
Research and seminar opportunities:

- Course work for every student is suited to his or her individual research interests in conjunction with an adviser.
- Students are encouraged to attend weekly departmental seminars.

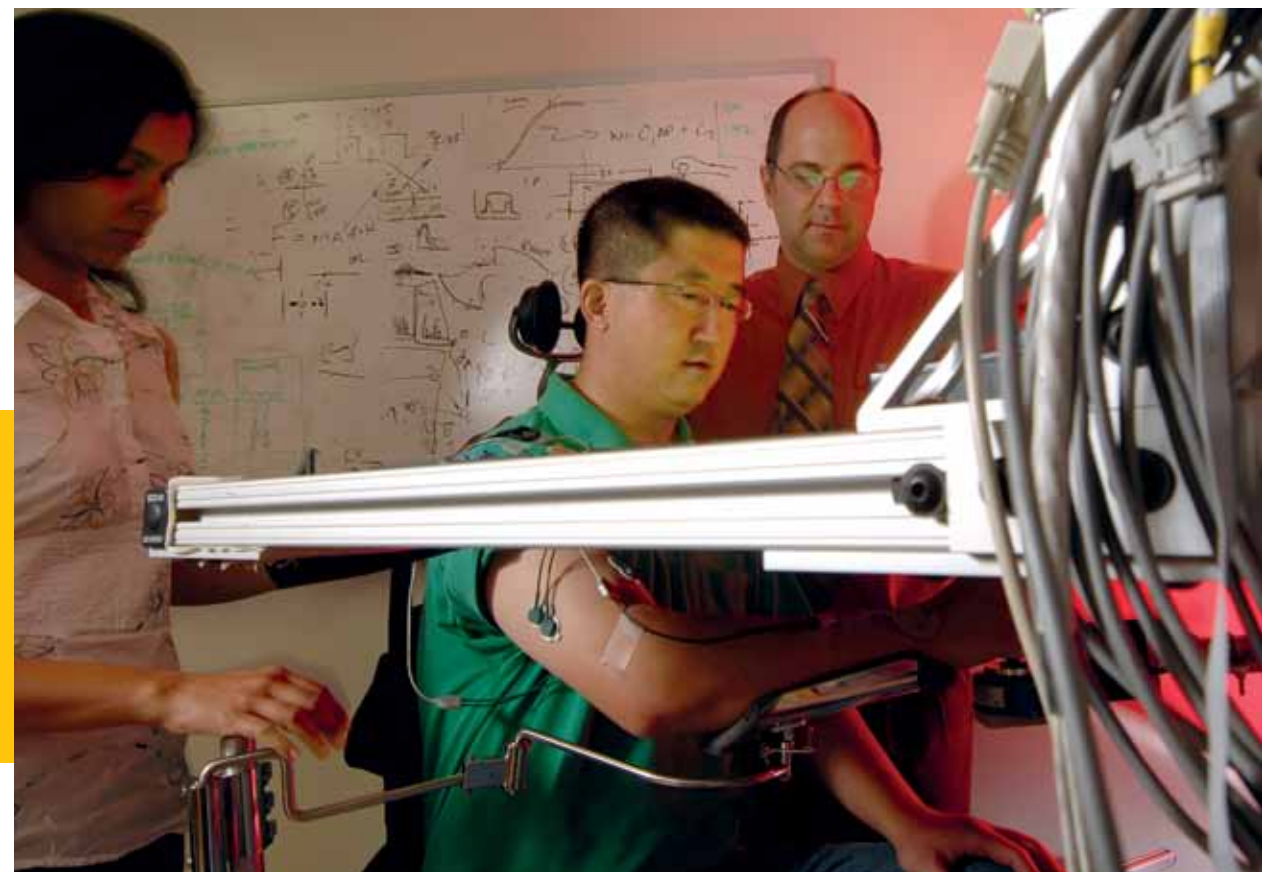
Eligibility:

- This degree program is designed for working engineers. Students applying to the program are required to have at least one year of post-baccalaureate professional work experience prior to starting the program.

For more program details, including requirements and course descriptions, see the *Graduate Bulletin* at marquette.edu/grad.



Marquette offers a master of science in healthcare technologies management in collaboration with the Medical College of Wisconsin. The program is the first in the United States to combine business, medical technology and healthcare and prepares students for management positions in the medical device industry. For more information, visit marquette.edu/hctm.



YOUR FACULTY MENTORS



Dr. Said H. Audi, associate professor
Pulmonary mass transfer, tracer kinetics, pulmonary hemodynamics

Dr. Scott A. Beardsley, assistant professor
Human visual processing, neural engineering, functional imaging, mathematical modeling

Dr. Taly Gilat-Schmidt, assistant professor
Medical imaging systems, CT, image reconstruction

Dr. Jay Goldberg, P.E., associate professor, director of the healthcare technologies management program and Lafferty Professor of Engineering
Biomaterials, medical device design failure analysis, forensic engineering

Dr. Gerald F. Harris, FAIMBE, professor, and director of the Orthopaedic Research and Rehabilitation Engineering Center
Quantitative assessment of neuromuscular function, human motion analysis, orthopedic biomechanics, data acquisition and control, real-time analysis

Dr. Dean C. Jetter, P.E., FAIMBE, professor and director of graduate studies
Implantable transcutaneous radio frequency power transfer, biotelemetry, biomedical instrumentation, radio frequency circuit design and development

Dr. John F. LaDisa, assistant professor
Cardiovascular biomechanics, blood flow through stents, congenital heart disease, cardiovascular imaging, computational modeling

Dr. Lars E. Olson, associate professor
Optical instrumentation, tissue engineering, biological transport and circulation physiology, mathematical modeling of physiological systems, biosensors

Dr. Kristina M. Ropella, FAIMBE, professor, department chair, and director of the joint doctoral program in functional imaging at Marquette and the Medical College of Wisconsin
Signal processing, cardiac electrophysiology, functional magnetic resonance imaging

Dr. Robert A. Scheidt, associate professor
Human motor control, systems identification, rehabilitation engineering, embedded systems, product development

Dr. Brian Schmit, associate professor
Autonomic reflexes in spinal cord injury, role of interneuronal circuits in human spinal cord injury, rehabilitation engineering, embedded systems

Dr. M. Barbara Silver-Thorn, associate professor
Prosthetic limbs, soft tissue mechanics, rehabilitation engineering, orthopedic and dental biomechanics

Dr. Jack M. Winters, professor
Neuromuscular control systems, movement and tissue biomechanics, rehabilitation engineering, telehealth, neurofuzzy computing

For more information about the department's faculty members, including adjunct, associate and research, and their interest areas, visit marquette.edu/engineering/biomedical/facstaff.

FACULTY RESEARCH

Our faculty members have financial support from numerous government and private agencies, including the American Heart Association, the Birnschein Foundation, the Department of Education, the Dr. Ralph and Marion C. Falk Medical Research Trust, the National Institute on Disability and Rehabilitation Research, the National Institutes of Health, the National Science Foundation, and Shriner's Hospitals.

Modeling and computing

Drs. Said H. Audi, Scott A. Beardsley, John F. LaDisa and Lars E. Olson

Current physiology and functional imaging research projects include the study of lung, heart and vascular disease. Faculty are using mathematical modeling, simulation and high-performance computing to study mechanisms of normal and abnormal circulation. An important aspect of the research involves determining model parameters that are useful for patient evaluation in a clinical setting. Faculty are also using models to develop implantable devices, such as stents, to treat cardiovascular disease in pediatric and adult populations. For more information, visit marquette.edu/engineering/biomedical/research_modeling_computation.

Medical imaging systems

Drs. Beardsley, Taly Gilat-Schmidt, Kristina M. Ropella, Robert A. Scheidt and Brian Schmit

Faculty at Marquette and the Medical College of Wisconsin are engaged in research related to functional imaging of organ physiology. In the past decade, Marquette and MCW faculty have worked to make technological advancement of functional magnetic resonance imaging and using the technique to understand brain and nervous system activity when individuals perform sensory, motor and cognitive tasks. In addition, advances in micro-CT and micro-SPECT technologies allow researchers to study other organ systems, such as lung and heart, in small animals. Current research projects include investigating dose reduction, scatter reduction and energy-weighting techniques for CT; designing a dynamic multipinhole micro-SPECT system; and investigating a dedicated breast CT system with an inverse geometry. For more information, visit marquette.edu/engineering/biomedical/research_imaging.

Medical devices

Drs. Dean C. Jetter, LaDisa, Olson, Scheidt, Schmit and M. Barbara Silver-Thorn

Research focuses on a broad range of diagnostic and therapeutic instruments, as well as assistive devices that include prosthetic limbs, robotic-assisted rehabilitation, a human-powered nebulizer, vascular stents, biotelemetry and implantable devices. The human-powered nebulizer is a low-cost, electricity-free alternative to commercial nebulizers designed to bring gold-standard medical treatment to resource-poor communities around the world. With industry sponsors, our faculty also focus on the design and prototype development of several implantable and external biomedical devices, such as multiple-channel telemeters and wireless transcutaneous radio frequency-powering systems for applications such as auditory prosthesis, artificial hearts, nerve regeneration stimulators, and a variety of monitoring and powering needs. For more information, visit marquette.edu/engineering/biomedical/research_devices.

Neurosystems

Drs. Beardsley, Michelle Johnson, Ropella, Scheidt, Schmit and Jack M. Winters

Through integration of human psychophysics, electrophysiologic measures, functional imaging and mathematical modeling, researchers investigate mechanisms of communication and control in the nervous system. Research focuses on the neural representation of sensory and motor information for perception and action in the human brain, particularly as it relates to navigation and 3-D spatial representation. For more information, visit marquette.edu/engineering/biomedical/research_neurosystems.

Rehabilitation bioengineering

Drs. Gerald F. Harris, Johnson, Scheidt, Schmit, Silver-Thorn and Winters

Marquette has rapidly emerged as one the strongest programs in rehabilitative bioengineering, with a large core of rehabilitation faculty at Marquette and continually growing ties between it and the Medical College of Wisconsin. Research opportunities exist in orthopedic and rehabilitation engineering, human motion analysis, neurorehabilitation, telerehabilitation and performance assessment, rehabilitation robotics, and prosthetics. For more information, visit marquette.edu/engineering/biomedical/research_rehabilitation.

YOUR RESOURCES

As a graduate student in biomedical engineering, you'll have access to:

- a program that in 2010 was ranked in the top 40 of tier-one universities by *U.S. News & World Report*.
- extensive research laboratory facilities on and off campus, including collaborations with the Medical College of Wisconsin and the Clement J. Zablocki VA Medical Center.
- the new state-of-the-art Engineering Hall
- a program accredited by the North Central Association of Colleges and Schools.

Our graduate programs also provide excellent resources beyond the classrooms. Thanks to our location in downtown Milwaukee and community-connected faculty, you'll enjoy an urban setting with access to a vibrant arts scene, professional sports, restaurants and nightlife.

Marquette University

- Access to networking, career counseling, and job searching counselors and seminars through our free [Career Services Center](#)
- More than 20 academic centers and institutes that foster research in end-of-life care, ethics, neuroscience, rehabilitation engineering, transnational justice, water quality, sports law and others
- Access to more than 1.7 million volumes of books and bound journals, 22,000 journals and other serials in digital format, laptops for checkout, and extensive special collections ([Raynor Memorial Libraries](#) are open evenings and weekends)
- Access to a secure high-speed wireless network (54Mbps) for laptops and other devices
- Remote computer access to campus-only resources through our VPN
- [Student Health Service](#), [Counseling Center](#) and Campus Ministry
- [Sports recreation and fitness facilities](#)
- [Big East Conference](#) sports, including men's basketball, which has 27 NCAA appearances, 14 Sweet Sixteen appearances, three Final Four appearances and one NCAA championship (1977) and plays in front of 18,000 fans at the Bradley Center

“ I am grateful for the training I received at Marquette. In addition to fostering my passion for research, the faculty taught me the importance of using multidisciplinary approaches, rigorous experimental design through data analysis, and clarity in writing and presentation.”

Dr. Larissa Shimoda, Grad '92, '95
Assistant professor
Pulmonary and critical care medicine at
Johns Hopkins Asthma and Allergy Center
Baltimore



Milwaukee

- The Milwaukee metropolitan area has approximately 1.7 million people, ranking among the top cities in the United States by population
- Home to nine fortune 500 company headquarters, including Harley-Davidson, Johnson Controls, Northwestern Mutual and Rockwell Automation
- Milwaukee offers many art and cultural opportunities, including a [repertory theatre](#), a [symphony orchestra](#), two opera companies, a [ballet company](#), diverse art galleries, a [public museum](#), the [Milwaukee County Zoo](#) and the [Milwaukee Art Museum](#)
- Professional sports include baseball ([Brewers](#)), basketball ([Bucks](#)), hockey ([Admirals](#)), soccer ([Wave](#)) and skating exhibitions at the [Pettit National Ice Center](#) (an Olympic training facility)
- Known as the city of festivals, Milwaukee has abundant celebrations throughout the year honoring the city's diverse heritage, including [Summerfest](#) — the world's largest outdoor music festival
- More than 10 miles of lakefront, 1,500 restaurants and 15,000 acres of parks

YOUR INVESTMENT

Furthering your education is an investment you can count on. Financial aid — in several forms — can help meet the costs of your graduate education at Marquette.

Tuition*

For full-time students:

Nine credit hours per semester at \$945 per credit = \$8,505 per semester

For part-time students:

Three to six credits per semester at \$945 per credit = \$2,715 to \$5,430 per semester

*Figures are based on average credit hours taken per semester and exclude service fees and/or continuous enrollment/continuation course fees. Per-credit cost valid until May 2012.

Merit-based aid

Students with promising credentials have an opportunity to receive significant amounts of financial aid in the form of research and teaching assistantships, tuition scholarships, and fellowships. Our department awards six teaching assistant positions requiring 20 hours of laboratory commitment a week and an additional 20 hours of class and thesis commitments per week. We also award one research assistant position and a variety of scholarships and fellowships with a stipend of up to \$24,000 per year. Please contact the department for application deadlines, eligibility and requirements.

Need-based aid

Enroll as a half- or full-time student in a degree program (at least four credit hours, usually two or more classes a semester), and you may be eligible for loans distributed through the [Office of Student Financial Aid](#). Most student loans have competitive interest rates and do not require repayment until after you complete your course of study.

To apply, file the Free Application for Federal Student Aid each year between January 1 and mid-February. It's available from the [Office of Student Financial Aid](#) or at fafsa.ed.gov. Once you have been admitted to your program and completed your financial aid paperwork, we will determine your eligibility and send you a notice explaining what financial aid you are eligible to receive from the university.

Additional resources

- Marquette offers a convenient payment plan that divides tuition costs into monthly installments. For more information, visit marquette.edu/mucentral or contact Marquette Central at (414) 288-4000.
- Employment assistance is available.
- Private lenders feature special educational loans.
- Your employer may offer a tuition-remission plan.
- Some private foundations offer financial aid for graduate study.
- Tax credits can be claimed for work-related educational expenses.

“

I have hired, managed and worked with several alumni of Marquette's biomedical engineering program. They do well in their positions, require minimal on-the-job training, and are hard working and highly competent. Compared with their peers from other graduate programs, they are more hands-on and practical in their approach to solving problems.”

Dr. Eric G. Lovett, Eng '91, Grad '93, '96

Director of research

CVRx Inc.

Minneapolis

YOUR OPPORTUNITIES

You'll find that our graduates have established rewarding careers in academia, industry, medicine, clinical research and law and are continuing their education at notable U.S. universities. The need for qualified biomedical engineers is strong, and a Marquette degree will open a world of new opportunities for you.



YOUR FIRST STEP

We invite you to apply.

Application requirement checklist:

- Online application at marquette.edu/grad/apply (must be submitted before all other admission materials)
- Application fee
- Official transcripts from all current and previous colleges/universities except Marquette
- Three letters of recommendation
- A brief statement of purpose that includes a proposed area of research specialization
- (Doctoral applicants only) Submission of any English-language publications authored by applicant, including master's thesis (submission of publications is optional but strongly recommended)
- GRE scores (general test only)
- (Master of engineering applicants only) An interview with the master of engineering program director
- (International applicants only) TOEFL score or other acceptable proof of English proficiency
- If necessary, submit any additional hard-copy materials in one envelope to:

Marquette University Graduate School
P.O. Box 1881
Milwaukee, WI 53201-1881



We invite you to speak with a faculty member.

Dr. Dean C. Jeutter

Professor and director of graduate studies
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MARQUETTE
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Marquette University Graduate School

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marquette.edu/grad