NDSU Biomedical Engineering Graduate Program Handbook

July 2024

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Introduction

This handbook describes the Biomedical Engineering (BME) Graduate program at North Dakota State University (NDSU). The BME graduate curriculum, Plan of Study, policies, regulations, and procedures applicable to the student pursuing a graduate degree are contained herein. This handbook contains policies and procedures that apply specifically to the NDSU BME Graduate Program and include but are not limited to the policies required by the NDSU Graduate School. *Students should also refer to the documentation provided by the Graduate School for additional information regarding the policies and procedures that apply to all graduate students*. This document is also intended to:

- Be a resource for graduate students and faculty in the BME graduate program;
- Provide information related to policies, procedures, and forms required by the Graduate School; and
- Help students design a schedule that will assist them in graduating in a timely manner.

Information about the BME faculty, degree requirements, and other program-related information can be found on the BME Department website (http://www.ndsu.edu/coe/bme).

Websites for Graduate Students

- Biomedical Engineering: http://www.ndsu.edu/coe/bme/
- College of Engineering (COE): https://www.ndsu.edu/coe/
- NDSU Graduate School: http://www.ndsu.edu/gradschool/
- Graduate School forms: http://www.ndsu.edu/gradschool/graduating_students/forms/
- NDSU Graduate Bulletin: https://catalog.ndsu.edu/graduate/
- Disquisition Formatting Guidelines: http://www.ndsu.edu/gradschool/graduating_students/dtp/format/
- NDSU Policies: http://www.ndsu.edu/policy/
- Equal Opportunity and Diversity: https://www.ndsu.edu/fileadmin/policy/100.pdf
- Admissions Policies: https://catalog.ndsu.edu/graduate/admission-information/
- Privacy of Records: https://www.ndsu.edu/onestop/records/student/privacy
- NDSU One Stop: https://www.ndsu.edu/onestop/
- Code of Academic Responsibility and Conduct: https://www.ndsu.edu/fileadmin/policy/335.pdf

NDSU Biomedical Engineering Graduate Program

The BME program offers two graduate degrees in Biomedical Engineering: 1) Master of Science (M.S.) and 2) Doctor of Philosophy (Ph.D.). There are two options for the M.S. program: thesis-based and project-based.

The mission of the BME program is to:

- Meet the needs of regional students interested in biomedical engineering.
- Attract women and under-represented minorities into a developing field.
- Educate and train students through courses and research focused on biomedical research and device development.
- Advance the biomedical knowledge base through collaborative research directed by faculty from NDSU's College of Engineering, UND's School of Medical and Health Sciences and College of Engineering and Mines, and other qualified researchers from the two universities.
- Develop intellectual property to generate company spin-offs, attract new companies, and subsequent economic development through biomedical research and device development.

The BME faculty members have teaching and research expertise in but not limited to the following areas:

- Biomechanics
- Bioinstrumentation
- Biodevice design
- Biosignals and data analytics
- Biomanufacturing
- Multi-scale modeling and simulation
- Biomaterials
- Materials synthesis and characterization

1. Admission to the BME Graduate Program

Admission to the BME Graduate Program is granted on a competitive basis. In general, admission is dependent upon the following items:

- Undergraduate GPA and other academic activities;
- Graduate Record Examinations (GRE) scores (can be waived by advisor recommendations);
- TOEFL or IELTS scores (required for international students);
- Area of interest; and
- Faculty members' availability to advise students in a particular area of interest.

1.1. Application Procedure

The general information about NDSU Graduate School is provided by the Graduate School website: https://www.ndsu.edu/gradschool. Prospective students should apply online directly through the website: https://www.ndsu.edu/gradschool/apply. In general, the following items will be required:

- Completed graduate school application form.
- Application fee.
- Official/certified copies of all undergraduate and graduate transcripts.
- Official report of the GRE general test score (optional)
- Official results from the Test of English as a Foreign Language (TOEFL) or International English Language Testing Systems (IELTS) (international students), as well as any other form of language proficiency test accepted by NDSU Graduate School. Check here for updated information.
- "Statement of Purpose" identifying immediate and ultimate degree objectives, technical areas of interest, and career objectives.
- Three letters of recommendation.

The Graduate School only processes applications accompanied by the application fee. Once all application materials have been received, the application will be forwarded to the BME program for consideration.

1.2. Admission Deadlines

Applications will be processed on an ongoing basis. However, submissions before the following deadlines are preferred to receive full consideration for assistantships.

- Fall Semester: Feb 15
- Spring Semester: Sept 15

Applicants will be notified of decisions on admission/assistantships as soon as they are available. Applicants are required to respond with their acceptance/rejection decisions within one month.

University Requirements: All application materials from U.S. students must be received at least one month before registration. For international students, the completed application and all required documents and test scores must be received by the Graduate School before May 1 for the fall semester and before October 1 for the spring semester.

1.3. Minimum Admission Requirements

All applicants are expected to have the following minimum requirements:

- B.S. degree or M.S. degree in ABET accredited engineering programs (preferred). Students with degrees in other disciplines may be admitted conditionally with the requirement of completing necessary undergraduate engineering courses. The exact requirements will be determined on a case-by-case basis.
- A minimum GPA of 3.0 (on a 4.0 scale) for admission at full standing; or
- Have been earning at least a 3.0 GPA over the past two semesters of graduate studies at an accredited institution.

International students, in addition to the above requirements, are also expected to have:

- Satisfactory GRE score - the minimum combined score is 300 (Quantitative and Verbal) with a minimum Quantitative score of 155. However, the faculty advisor may waive the GRE requirement based on other applicant qualifications (e.g., outstanding publication record, strong research capability, etc.).
- Satisfactory English exam scores. The minimum requirements are listed below.

TOEFL Paper	TOEFL Computer	TOEFL Internet	IELTS	Duolingo
550	213	79	6.5	105

In special circumstances, applicants who do not meet the above requirements may be conditionally admitted if they are recommended for admission by a faculty advisor and their scores meet the minimum English proficiency requirements set forth by the NDSU Graduate School.

Higher English test scores are required to qualify for graduate teaching assistantships in accordance with the requirements of the NDSU English Language Proficiency for Graduate Teaching Assistants.

Applicants with a non-engineering Bachelor's Degree: Applicants who do not have a degree in engineering may be admitted into the M.S. or Ph.D. program; however, they may be required to complete some undergraduate engineering coursework prior

to enrolling in graduate courses. The faculty advisor and BME Graduate Program Coordinator will determine the required coursework.

Applicants who do not possess an engineering or science degree are required to submit GRE scores for consideration for admission into the graduate program. For special cases, the faculty advisor may submit a GRE waiver request to the BME program coordinator.

1.4. Graduate School

The Graduate School has various campus-wide policies and procedures that apply to all students enrolled in a graduate program. Graduate school applicants should initially contact the Graduate School to submit their applications. The Graduate School will issue admission letters.

Graduate School Forms:

The following forms can be found on the Graduate School website

(http://www.ndsu.edu/gradschool/current_students/forms/):

- Request for Change: Plan of Study or Advisor/Supervisory Committee
- Request to Schedule Examination
- Master and Doctoral Plan of Study
- Continuation of Program/Degree Objective Change
- Request to Withdraw from the Graduate School
- Report of Preliminary Exam
- Report of Final Exam
- Request for Delayed Enrollment
- Request for Reactivation
- Request for Leave of Absence
- Commencement Participation
- Degree Application/Exit Survey

Contact Information

Mailing Address:	***Physical Address:***	Email:
NDSU Graduate School	NDSU Graduate School	ndsu.grad.school@ndsu.edu
NDSU Dept 2820	106 Putnam Hall	Phone: 701-231-7033
PO Box 6050	1349 12th Ave NW	Fax: 701-231-6524
Fargo, ND 58108	Fargo, ND 58102	

2. Information for BME Graduate Students

2.1. BME Graduate Program Coordinator

The BME Graduate Program Coordinator, appointed by the Dean of the College of Engineering, is responsible for graduate recruitment and admission processes, the graduate curriculum, and assisting students in the academic procedures and policies during their graduate studies at NDSU. The contact information for the current coordinator is as follows:

Dr. Long Jiang
Department of Mechanical Engineering
NDSU Dept 2490
PO BOX 6050
North Dakota State University
Fargo, ND 58108-6050
Email: Long.Jiang@ndsu.edu
Phone: 701-231-9512
Office: Dolve 207

2.2. BME Advisory Council

The BME Advisory Council consists of the Graduate Program Coordinator and four other faculty members from the BME graduate faculty. The primary function of the Council is to assist and advise the BME program coordinator on academic and administrative issues. The detailed functions of the Council are described in the BME program bylaws available on the BME website.

2.3. Major Advisor

All incoming graduate students will be assigned a major faculty advisor. All Ph.D. students must have their major advisors committed before an admission can be issued.

The major advisor, who typically is an expert in the student's area of interest, will serve as the student's mentor and will assist the student in preparing their Plan of Study. They will help ensure that the student is making satisfactory progress towards completion of the degree. The major advisor also serves as the chair of the thesis/dissertation supervisory committee, provides guidance in the selection of a research topic and supervises the research project. Students can have a single major advisor or co-advisors, where multiple faculty members choose to share the advising task.

The BME program recognizes that it may occasionally be in a student's best interest to change advisors. For instance, a new student might initially select a major advisor but later wish to accept a Graduate Research Assistant (GRA) position with a different faculty member. In these situations, ethical conduct dictates that the student should consult their current advisor before committing to a new one. Similarly, prospective advisors are strongly encouraged to communicate with the current advisor before agreeing to advise a graduate student previously assigned to another advisor.

2.4. Thesis/Dissertation Supervisory Committee

The supervisory committees serve to guide graduate students throughout their master's/Ph.D. research projects, help them develop skills in conducting original and independent research, monitor their research progress, and assess the outcomes at various stages. The members of the committees, usually experts in the students' areas of interest or related fields, provide a broad range of knowledge for the students' research. The students are expected to meet with their supervisory committees throughout their graduate studies.

The supervisory committee for a master's student must consist of at least **three** members:

- The major advisor who chairs the supervisory committee.
- A faculty member from NDSU graduate faculty.
- A faculty member from the UND BME graduate faculty or as appointed by the UND BME program director.

The supervisory committee for a Ph.D. candidate must consist of at least **four** members:

- The major advisor who chairs the supervisory committee
- A faculty member from NDSU BME graduate faculty.
- A faculty member from the UND BME graduate faculty or as appointed by the UND BME program director.
- A Graduate School Representative (GSR) chosen by the student, in consultation with the committee chair.

The eligibility requirements for the GSR can be found on the graduate school website.

The GSR should be invited to meetings but is not required to attend. At a minimum, the student must meet with the supervisory committee to present their research proposal no later than one semester before the final defense. Regular meetings with the major advisor and committee members allow the faculty and the student to work

together in developing their research and technical skills. They also allow the faculty members to keep the student on track for graduating on time and refine their Plan of Study as new courses and/or new interests arise.

Together, the student's major advisor and supervisory committee help guide the student towards completion of their degree by:

- Helping to develop the student's technical skills (i.e. helping to develop a Plan of Study) to the point where they have the skills necessary to conduct research.
- Helping the student learn what is involved in conducting original research.
- Helping to develop the student's research skills.

The major advisor and the supervisory committee are responsible for monitoring the student's progress and, if necessary, terminating the student's studies if the student is not making sufficient progress. It is imperative that the student begin working closely with their major advisor and supervisory committee as soon as possible after enrollment.

2.5. Plan of Study

All students must consult with their major advisor and submit a Plan of Study, typically by the end of the second semester of study. After being completed by the student and reviewed by the major advisor, the Plan of Study must be submitted via DocuSign to NDSU Graduate School for the BME Graduate Program Coordinator to sign.

2.6. Support and Funding

Financial support for graduate students may come from the BME program or through research grants administered by individual faculty members. A full-time assistantship consists of 20 hours/week; graduate assistants on full assistantships are not allowed to work on a second assistantship without prior approval from the Graduate Dean (i.e., 20 hours/week maximum). Any graduate student working 10 or more hours per week may receive a full or partial tuition waiver as well as a stipend, subject to the NDSU policies in effect at the time of enrollment. Financial support is available in the form of Graduate Research Assistantships (GRAs), Graduate Teaching Assistantships (GTAs), and Graders.

GRAs

Funding for Graduate Research Assistantships (GRAs) comes from grants or contracts received by faculty members from various agencies. As a stipulation of

these awards, the faculty member is responsible for overseeing that the proposed research is completed in a timely manner as well as for assuring the quality of the research. GRA recipients are paid a base stipend and are eligible for a full or partial tuition waiver according to tuition waiver requirements (which may vary across colleges or departments). Typically, in addition to fulfilling the requirements of the contracts, the research funded by the grant serves as the foundation for the student's thesis or dissertation, providing in-depth knowledge into their particular field of research.

GTAs and Graders

Support for GTAs and Graders comes from the student's home department. GTAs may be responsible for teaching lower-level courses or laboratories for the department. Graders are responsible for grading homework, quizzes, exams, etc. for individual courses. In return for their work, they receive a stipend and may be eligible for a full or partial tuition waiver per the waiver requirements.

To be eligible for GTA or Grader positions, international students must meet the English Language Proficiency requirements specified by the Graduate School. The minimum test score requirements for these positions are provided on the graduate school website.

Students wishing to be considered for a GTA or Grader position should discuss with their faculty advisors for opportunities in their home departments. The positions are awarded on a competitive basis, and the decisions to award them are based on the faculty advisor's recommendation and the student's progress toward graduation and area of expertise.

All graduate students who receive assistantships should successfully complete all university-required training. NDSU Graduate School withdraws the Tuition Waiver for students who have not completed their training.

Graduate Assistantship Contracts

The NDSU Graduate School requires a contract be completed for graduate students who are being offered a graduate assistantship (GA). An assistantship contract for GRA or GTA has the compensation, duties, hours, or other significant aspects of the assistantship. The contract provides clear expectations of responsibilities, establishes evaluation procedures, and makes explicit the compensations GAs will receive for their work.

Contract templates are available on the NDSU Graduate School website at: https://www.ndsu.edu/gradschool/faculty_and_staff/graduate_school_forms/#c314427. There are separate templates for research, service, and teaching assistants, and the template utilized must correspond with the job code specified on the student's

hiring form. The contract is initiated by the hiring department and it should accompany the hiring form as it is routed to the Graduate School.

2.7. Enrollment Status and Credit Load

Nine credits are considered a full-time graduate load for students not receiving departmental support (assistantships). To receive financial aid, students must be enrolled at least half-time (5 credits). Graduate assistants working 20 hours per week are considered full-time if registered for five or more graduate credits. Federal law requires all international students with a 20-hour per week assistantship to carry at least six credits for full-time status. Loan deferment may also require full or half-time status. Eligibility varies with financial aid programs and students should contact their lender or the Financial Aid Office for requirements. More information about credit load is described in NDSU Graduate Student Handbook.

Students enrolled in less than half time credits (5) and being supported by NDSU may be subject to FICA withholding on their wages. Students should contact the NDSU Payroll Office for information prior to enrolling part-time.

Graduate students wishing to register for more than the standard maximum of 15 credits in a regular semester, need to secure approval from their faculty advisor, BME program coordinator, as well as from the Dean of the Graduate School. The request should include, 1) How many credits in which they are currently registered, 2) How many additional credits in which they wish to enroll and 3) Justification for the request. The BME program coordinator will review the request, and if approved, will forward it on to the Dean of the Graduate School.

Summer Semester

Summer Semester credit requirements may vary depending on Financial Aid eligibility requirements. Check with the Financial Aid office to determine the number of credits in which you are eligible to enroll. Likewise, International students should check with their international programs advisor to verify their eligibility requirements.

Tuition waivers may be available for the summer semester if a student worked enough hours to be eligible for the waiver in the spring semester. Students may also be hired on an assistantship during the summer semester, but must enroll in at least one credit hour and work 160 hours over the summer months.

2.8. Graduate Student Orientation

All new graduate students are encouraged to attend the orientation organized by the Graduate School.

Office Space

Office space is provided by the student's major advisor and home department. Priority will be given to students with research or teaching assistantships.

Should the office/lab space be abused by disrespecting fellow students, misusing department property or negligence, the office/lab space will be revoked.

Keys/Card Access

Graduate students frequently require keys or card key access to offices, laboratories, and the buildings. The major advisor must approve the requests for card/key access for their students through their home department office. Students should complete all necessary safety training and meet the requirements set by their home departments before access will be granted.

2.9. Advising and Registration

Each semester, during Advising Week, students will meet with their advisors prior to enrolling in the upcoming semester. Students may consult the BME program coordinator for questions regarding program requirements.

Registration for classes, for the most part, should be completed by April 30 (for the Fall Semester) and November 30 (for the Spring Semester). After these dates, courses will be evaluated and those that do not meet the required minimum enrollment number may be at the risk of cancellation.

2.10. Graduate Courses

The BME graduate course list is being updated every year. For the most updated course list, students should visit the BME website. Special notes about some BME courses:

Internship: Register under BME 795 Field Experience. Off-campus internship should be registered through NDSU Career Center and be administered by the Career Center. The tuition for off-campus internship credits is not covered by the tuition waiver. On-campus research work at a laboratory other than the student's thesis committee members' laboratories is acceptable and the work should not be part of the student's Master's thesis or Ph.D. dissertation research.

Independent Study: Register under BME 793. Student who plans to take BME 793 should contact the BME program director to open a section on Campus Connection for registration.

Graduate Preparation: This can be in terms of teaching or writing. Options include:

1. College Teaching Certificate through the Office of Teaching and Learning. Register for BME 892 (3 Credits).

2. Teaching a course as the main instructor. TA does not count. Register for BME 892 (3 Credits).

3. Taking grant writing courses. Acceptable courses include ENGR 722 (3 Cr), ENGL 659 (3 Cr), ENGL 751 (1 Cr) and ENGL 752 (1 Cr).

A maximum of 10 credits (M.S.), 16 credits (Ph.D. 90 credits), and 15 credits (Ph.D. with M.S.) can be transferred from the approved UND BME courses in the BME graduate course list. Ph.D. students who already have an M.S. degree will automatically bring in 30 credits, reducing the total number of credits from 90 to 60.

UND Courses: Students should register for UND courses through the collaborative registration process.

2.11. BME Graduate Seminar

All graduate students are required to enroll in BME Graduate Seminar (BME 790) for three credits, per degree, during their pursuit of the M.S. degree and/or Ph.D. degree. Students may take seminar courses offered by other engineering or science departments after completing three credits of BME 790. Attendance and participation in seminar activities are required for passing the seminar course.

2.12. Co-op/Internship Work Experience

The BME program encourages graduate students to pursue cooperative education or internship opportunities when available. However, students who wish to pursue such opportunities should notify their major advisors well in advance of the employment dates so that appropriate arrangements can be made. Prior to acceptance of a co-op/internship opportunity, it is expected that the student will have completed all coursework and a majority of the research, and submitted a draft copy of the thesis or dissertation, unless alternative arrangements have been approved by the major advisor.

2.13. Time Limitations

Graduate study for the Ph.D. degree in biomedical engineering typically takes four to five years for full-time study beyond the baccalaureate degree.

Graduate credit for any course work that is more than seven calendar years old at the time of the final defense cannot be used to satisfy degree requirements for an M.S. degree. Likewise, any coursework that is more than 10 years old at the time of the final defense cannot be used to satisfy degree requirements for a Ph.D. degree.

The final defense must be repeated if the final copy of the approved thesis/paper/dissertation is not delivered to the Graduate School or if any other degree requirements have not been completed within one year of the date of the final defense.

If a period of time, two years or greater, lapses before the final copy is submitted, the student must re-apply to the Graduate School, re-defend the thesis, and also must register for a minimum of two credits. The degree date is based on the date when final copies are submitted to the Graduate School.

2.14. Dismissal from the Graduate Program

The progress of each graduate student will be reviewed by the student's major advisor each semester. If a student's progress is unsatisfactory, the student may be subjected to probation or dismissal from the BME Program.

Conditions for Dismissal

Any graduate student who has completed 12 or more hours of graduate coursework and who has not attained at last a 3.0 cumulative GPA will be subject to probationary status. If the student does not fulfill the 3.0 cumulative GPA requirement in the subsequent semester (following the probationary status), the student may be dismissed from the program.

Any student who has completed the formal coursework but is not making satisfactory progress toward the completion of the remaining degree requirements, may be dismissed from the program.

Dismissal Procedure

For any student subject to dismissal, the student's major advisor and supervisory committee will be consulted prior to making a final decision.

The dismissal is effective at the end of the semester in which the decision is made.

The student will be notified in writing of the potential dismissal within four weeks in which the decision is made.

The student may appeal the decision of dismissal within four weeks of notification by submitting a letter to the BME program coordinator.

More information about NDSU policies on academic standing, warning, probation, and dismissal can be found here https://catalog.ndsu.edu/graduate/graduate-school-policies/#academicstandardstext.

2.15. Leaving the BME Program

Students are required to return the key(s) for the office, laboratories, and building, clean up office/lab spaces, and return any department-owned books, solution

manuals, computers, or other equipment to their home department. The BME program also requests contact information from graduates to keep a profile for each alumnus.

3. M.S. Program in Biomedical Engineering

This section of the graduate handbook is intended to help students enrolled in the M.S. program and their major advisors and supervisory committees during the students' work on their Master of Science Degree in BME. This section includes:

- Requirements for the M.S. degree in biomedical engineering.
- List of milestones and requirements a student needs to meet in order to earn an M.S. degree.

The milestones and requirements of the M.S. program are described herein, subject to the requirements of the NDSU Graduate School. The student's major advisors and supervisory committees are expected to update them as necessary to ensure that the students receive the education and training they will need upon leaving NDSU.

3.1. M.S. Degree Options in Biomedical Engineering

Two M.S. Degree options in Biomedical Engineering are available.:

- Thesis option (M.S. Thesis), which emphasizes research, the ability to analyze data, and preparation of a scholarly thesis.
- Project option (M.S. Project), which emphasizes a broader understanding of the major area.

The main difference between the two options for an M.S. degree is that the final document developed by the student is a *thesis* under the thesis option and it is a *paper* under the project option. Only students enrolled in the thesis option are eligible for GTAs or GRAs. Students who were admitted into the *thesis* option and have received GTAs or GRAs may not change to the *project* option. Special circumstances will be addressed on a case-by-case basis.

A minimum of 30 graduate credits is required for the M.S. degree at NDSU. For the thesis option, 16 of the 30 must be didactic credits. For the project option, 21 of the 30 must be didactic credits. See more information on didactic credits and credits counted for graduate degrees in Graduate College Policies.

3.2. M.S. Thesis Option Requirements

The M.S. thesis typically documents the student's first exposure to the research process. This document often includes:

- Problem statement (the objective, or hypothesis, of the thesis).

- Explanation of present knowledge related to the problem.
- Presentation of the new knowledge created by the student in meeting this objective, or in testing the hypothesis.

The requirements for the thoroughness and significance of the latter two sections are determined by the student's major advisor and supervisory committee. Students who select the thesis option need to work closely with both their major advisor and supervisory committee as they move forward on the research. Significant guidance from the major advisor and supervisory committee is expected since this is often a student's first exposure to the research process.

A BME course list is being updated every semester and is being maintained on the BME website.

Required:

Anatomy Physiology: 3-6 credits

NDSU-BIOL 660 Animal Physiology (3 credits)
UND-BME 630 Anatomy and Physiology for Biomedical Engineers (6 credits; currently tuition charge would apply for NDSU students)

Seminar: 3 credits (1 or 2 credits per semester)

NDSU-BME 790 Seminar (1-2 credits)
UND-BME 670 Seminar for Biomedical Engineers (1-2 credits)
Note: The NDSU and UND seminar courses are offered together. NDSU students can register for UND BME 670 only if NDSU BME 790 is not offered.

Engineering Core Courses: 6-9 credits (2-3 classes)

Thesis: BME 798 (9 credits)

Electives:

Internship (industrial, clinical, or research lab): 0-3 credits
Graduate Preparation: 0-3 credits
Elective Courses (approved by advisor): up to 9 credits

Note: Contact the BME program director before registering for internship, graduate preparation classes or independent study. See Section 2.10 for notes on some BME courses.

3.3. Thesis Proposal

The purpose of the thesis proposal is to allow the student to demonstrate their ability to identify a problem in their area of interest and formulate a strategy on how to apply their skills in addressing the problem. At this stage, the student is not expected to have any concrete results, but rather an understanding of the problem and how they might approach it.

The thesis proposal is to be both a written and oral presentation of what the student proposes to work on for their M.S. thesis. A 2 to 5-page written proposal should be delivered to the supervisory committee at least one week before the oral presentation. The oral presentation must be held no later than one semester prior to the final thesis defense. The content of the proposal should include the following:

- Objective of the student's work, or the hypothesis they wish to investigate.
- Explanation of why this topic is significant.
- Literature review and an explanation of what others have done in the area.
- Explanation of what methods the student proposes to use to attack this problem.
- Speculation on what the results may be.
- Timeline for completion of the work.

3.4. Publication

Students pursuing the Thesis Option are required to write and submit at least one manuscript to a refereed journal or to a refereed conference (as determined by the student's major advisor and supervisory committee) prior to the final thesis defense.

3.5. M.S. Project Option:

The M.S. project (non-thesis) option is intended for students who are currently in industry and more interested in understanding existing knowledge. A research paper (Master's Paper) must be completed as part of the degree requirements. No more than 3 credits of BME 797 (Master's Paper) may be applied to the degree as part of this requirement. The nature, scope and depth of a Master's Paper are determined by the student's major advisor and supervisory committee. Some examples of a paper would be:

- Survey of existing literature in a given area along with an original example demonstrating and contrasting these methods; or
- Development of a new product along with a survey of how it compares with existing devices.

The limited new knowledge developed in the examples above prevents the paper from being a thesis. If, however, the student adds to their work and develops a technique

to significantly improve previous methods, the work may be considered an M.S. Thesis. The format for the Master's Paper typically includes the following:

- Problem statement
- Explanation of present knowledge
- Original Example demonstrating or assimilating several existing techniques

Required:

Anatomy Physiology: 3-6 credits

NDSU-BIOL 660 Animal Physiology (3 credits)
UND-BME 631 Anatomy and Physiology for Biomedical Engineers (4 credits; currently tuition charge would apply for NDSU students)
UND-BME 632 Anatomy and Physiology for Biomedical Engineers (4 credits; currently tuition charge would apply for NDSU students)

Seminar: 3 credits (1 or 2 credits per semester)

NDSU-BME 790 Seminar (1-2 credits)
UND-BME 670 Seminar for Biomedical Engineers (1-2 credits)
Note: The NDSU and UND seminar courses are offered together. NDSU students can register for UND BME 670 only if NDSU BME 790 is not offered.

Engineering Core Courses: 6-9 credits (2-3 classes)

M.S. Paper: BME 797 (3 credits)

Electives:

Internship (industrial, clinical, or research lab): 0-3 credits
Graduate Preparation: 0-3 credits
Elective Courses (approved by advisor): up to 15 credits

See Section 2.10 for notes on some BME courses.

3.6. Master's Paper Preparation Guidelines

The comprehensive paper is expected to provide evidence that the graduate student has a thorough understanding of a subject related to the field of biomedical engineering. Presenting a quality paper assures that the graduate student has the potential as a biomedical engineer to produce similar quality scientific research/design reports in their professional career. The Comprehensive paper requirement is satisfied by the completion of a written work that the student's supervisory committee certifies as providing:

- A good understanding of a fundamental subject in biomedical engineering.
- Representative outcomes of thorough research work accomplished by others or by the graduate student themselves.
- A thorough literature survey on the subject of the paper.
- Evidence of a systematic research/design approach to the subject of the paper.
- Competent use of the English language, good organization, and thorough editing.

In addition, it is expected that the graduate student writes and submits a draft of the paper to the major advisor during preparation for the final defense. The draft will be critiqued by the advisor. The student should revise and edit the paper before submitting the final version to the supervisory committee. While there are no specified page requirements for the paper, it should be highly polished and complete to meet the foregoing required criteria. The guidelines for the paper should adhere to the same NDSU Graduate School guidelines for thesis preparation.

Exceptions to any of the requirements noted above may be granted only upon approval by the student's major advisor, supervisory committee, and BME Graduate Program Coordinator.

3.7. M.S. Thesis/M.S. Paper Defense

Each student must present their thesis/paper in an oral defense administered by the student's major advisor and supervisory committee. At least two weeks prior to the defense, the student will submit the final draft of their thesis/paper to their committee, and at least seven calendar days before the defense date, the student must submit a completed Notification of Scheduled Examination to the Graduate School. At the conclusion of the final exam, the supervisory committee will record their approval or disapproval of the student's final exam. It is the student's responsibility to initiate the Report of Final Defense, and the completed form must be submitted to the Graduate School within two weeks of the exam.

A negative vote by more than one member of the student's committee will signify failure of the final exam. The student may repeat the exam only upon permission from a majority of their committee. A second attempt may take place at least one month after the failed exam as determined by the committee. Should the exam be failed twice, the student will not be given a third exam except by recommendation of the examining committee, program director, and special approval of the Dean of the Graduate School following consultation with the Graduate Council.

The Approval Page required by the Graduate School, will not be signed until all revisions have been approved by the examining committee.

Continuous enrollment is required until all degree requirements are completed, including submitting final copies of a thesis, paper, or dissertation. Students should carefully check all required paperwork and deadlines given on the Graduate School website.

3.8. Summary of the M.S. Program

Milestone	Time Frame	Purpose
Select the Major Advisor and Supervisory Committee	First to Second Semester	To graduate in a timely manner and to begin thinking about, and working on, the paper/thesis topic as soon as possible
Meet the Major Advisor	Regularly	Demonstrates progress towards the M.S. degree. Allow the Supervisory Committee and opportunity to: help develop the student's research and technical skills; keep the student 'on track' for graduating in a timely fashion; and refine the student's Plan of Study as new courses and new interests arise.
Complete M.S. Plan of Study	Second Semester	A list of courses in which the student needs to enroll in order to be provided with the technical skills needed to conduct graduate level work in the area of interest.
Develop M.S. Thesis Proposal (Thesis Option Only)	Second or Third Semester	Demonstrate the technical skills needed to conduct Master's level research in the area of interest: understanding the problem; understanding why the problem is significant; ability to develop a plan for how to solve the problem; and ability to read the technical literature in the proposal's subject area.
Defense of M.S. Thesis Proposal (Thesis Option Only)	At least one semester before the final	For the Thesis Option, the student must present his/her thesis proposal to the supervisory committee at least one semester prior to the final semester
Journal or Conference Manuscript Submission (M.S. Thesis Option Only)	Final Semester	Disseminate the knowledge obtained for the thesis. Students are recommended to submit a manuscript to a peer reviewed journal or technical conference as determined by the major advisor and supervisory committee.
M.S.Thesis/M.S.Paper Defense	Final Semester	The student must demonstrate the use of his/her skills to follow through on the plan to complete the research. The purpose of the defense is to evaluate whether or not the student (rather than someone else) completed the work being described in the paper/thesis, as well as that the quality of the work is worthy of a Master's level paper/thesis.

4. Ph.D. Program in Biomedical Engineering

This section is intended to help students enrolled in the Ph.D. program, their major advisors and their supervisory committees during the student's work on their Ph.D. degree in the BME program. This section includes:

- Requirements for the Ph.D. degree in biomedical engineering.
- List of milestones and requirements a student needs to meet in order to earn their Ph.D. degree.

4.1. Ph.D. Degree Options in Biomedical Engineering

A minimum of 60 graduate credits beyond the M.S. degree, or 90 credits beyond the B.S. degree is required for the Ph.D. degree in Biomedical Engineering. In addition, each student must pass a qualifying exam, consisting of a written component and an oral component, as well as a preliminary exam, i.e. Ph.D. dissertation research proposal writing and oral defense, before being formally admitted to candidacy for the Ph.D. degree. Once the student's dissertation has been completed, they must pass a final defense, focusing on the dissertation, before being awarded the Ph.D. degree. Specific details of the curriculum requirements and examinations for the Ph.D. degree are included below.

M.S./Ph.D. Option: A student enrolling in the Ph.D. program directly after obtaining a B.S. degree (i.e. without having an M.S. degree) may elect to first obtain an M.S. degree. The course and research (dissertation) credit requirements listed for the M.S. degree must be completed.

Ph.D. Option: The course credit requirements listed for the M.S. degree must be completed. The remaining 6-9 research (dissertation) credits, normally awarded for the completion of an M.S. thesis, may be replaced by any approved graduate level research or course credits.

4.2. Ph.D. Program Requirements

Required:

Anatomy Physiology: 3-6 credits

NDSU-BIOL 660 Animal Physiology (3 credits)
UND-BME 630 Anatomy and Physiology for Biomedical Engineers (6 credits; currently tuition charge would apply for NDSU students)

Seminar: 3 credits (1 or 2 credits per semester)

NDSU-BME 790 Seminar (1-2 credits)
UND-BME 670 Seminar for Biomedical Engineers (1-2 credits)
Note: The NDSU and UND seminar courses are offered together. NDSU students can register for UND BME 670 only if NDSU BME 790 is not offered.

Engineering Core Courses: 12-15 credits (4-5 classes)

Thesis: BME 899 (6-30 credits)

Electives:

Internship (industrial, clinical, or research lab): 0-6 credits
Graduate Preparation: 3-6 credits
Elective Courses (approved by advisor): up to 36 credits

Note: Contact the BME program director before registering for internship, graduate preparation classes or independent study. See Section 2.10 for notes on some BME courses.

Of all course credits, 15 must be from 700 or 800 level didactic courses. For other credit requirements, the BME program follows the graduate school doctoral degree policies.

4.3. Qualifying Exam

Due to the interdisciplinary nature of the BME program and the broad variety of student backgrounds, the program adopts a qualifying exam format that involves writing and oral presentation of a research proposal. See Appendix A for the qualifying exam policy.

4.4. Ph.D. Dissertation Proposal Defense

The Ph.D. dissertation proposal defense is also called Preliminary Examination at the Graduate School website. This component is taken after the student has passed the qualifying exam and at least one academic semester before the final defense. This exam, administered by the student's major advisor and supervisory committee, consists of a presentation and defense of the student's proposal for their dissertation research. It may also cover material from coursework that is fundamental to the dissertation. At least two weeks prior to the exam, the written proposal should be delivered to the supervisory committee. A Notification of Scheduled Examination must be submitted to Graduate School for approval at least seven calendar days prior to the exam date. The content of the proposal should include the following:

- Objective of the student's work, or the hypothesis they wish to investigate.

- Explanation of why the intended research work is significant.
- Literature review and an explanation of what others have done in the area.
- Explanation of what methods the student proposes to use to attack the proposed problem(s).
- Preliminary results or speculation on what the results may be.
- Timeline for completion of the work.

At the conclusion of the oral exam, the examining committee will record their approval or disapproval of the student's presentation and defense. It is the student's responsibility to initiate the Report of Preliminary Examination, and the completed form must be submitted to Graduate School within 14 calendar days of the exam.

A negative vote by more than one member of the student's examining committee will signify failure of this exam. Upon permission of a majority of the student's committee, the student will be allowed to take the oral exam a second time. The examining committee will specify a period of time, no less than one month that must elapse before the exam can be repeated. An exception to the time limit may be granted by the Dean of the Graduate School upon consultation with the examining committee members.

If both attempts to pass the exam fail, the student may request to take it a third time. This request, however, will require the support of the supervisory committee, BME Graduate Program Coordinator, and the Dean of the Graduate School.

Upon successful completion of the qualifying exam and Ph.D. dissertation proposal defense, the student will formally be admitted to candidacy for the Ph.D. degree.

4.5. Publication

All Ph.D. students are required to publish at least one original research paper, not a literature review paper, in a peer-reviewed journal prior to the conferring of their degree. The student's major advisor and supervisory committee will recommend the name or type of journals or conferences for publication.

4.6. Dissertation Defense

Each student is required to pass an oral final defense, which is administered by their supervisory committee, after all coursework and the dissertation have been completed. This examination will be concerned primarily with the dissertation, but it may also cover material from coursework, especially those courses fundamental to the dissertation.

At least one academic semester must elapse between the preliminary and final exams. A Notification of Scheduled Examination must be submitted to the Graduate School for approval at least seven calendar days prior to the date of the exam. At the

conclusion of the final exam, the supervisory committee will record their approval or disapproval of the student's final exam. It is the student's responsibility to initiate the Report of Final Defense, and the completed form must be submitted to the Graduate School within two weeks of the exam.

A negative vote by more than one member of the student's supervisory committee will signify failure of this exam. Upon permission of a majority of the supervisory committee members, the student will be allowed to take the exam a second time. The supervisory committee will specify a period of time, no less than one month that must elapse before the exam can be repeated. An exception to the time limit may be granted by the Dean of the Graduate School upon consultation with the supervisory committee members.

If both attempts to pass the exam fail, the student may request to take the exam a third time. This request, however, will require the support of the supervisory committee, BME Graduate Program Coordinator and the Dean of the Graduate School.

4.7. Summary of Ph.D. Program

Milestone	Time Frame	Purpose
Select the Supervisory Committee. Student should already have a major advisor selected upon admission.	First to Second Semester	To graduate in a timely manner and to begin thinking about, and working on, the dissertation topic as soon as possible.
Meet with Supervisory Committee	Each Semester or as recommended by the major advisor.	Demonstrate that progress is being made towards completion of Ph.D. requirements and allow the supervisory committee an opportunity to: ● Help develop the student's research and technical skills; ● Keep the student on track for graduating in a timely fashion; and ● Refine his/her Plan of Study as new courses and new interests arise.
Complete Ph.D. Plan of Study	Second Semester	Make sure that the courses in which the student enrolls will provide the technical skills needed to conduct Ph.D. level research in student's area of interest.
PhD Qualifying Exams: written and oral presentation.	After the majority of coursework has been completed.	The student demonstrates that he/she has the technical skills necessary to conduct Ph.D. level research in his/her area of interest.
PhD Preliminary Exam: dissertation proposal writing and oral defense.	Typically one to two semesters before final defense.	The student Demonstrates the following: ● he/she has an understanding of the proposed problem; ● he/she understands why the proposed problem is significant; ● he/she has developed a plan for solving the proposed problem; and ● he/she has read the technical literature in the area of interest
Publication in Peer Reviewed Journals	Prior to final defense.	To disseminate the new knowledge developed through the research and to demonstrate that the work is respected by external reviewers.
Defense	Final semester (at least one semester following Dissertation Proposal).	The student is able to use his/her skills and follow through on the plan to complete the research. This defense is an evaluation by the examining committee to make sure that the student (rather than someone else) completed the work being described in the dissertation, as well as that the quality of the work is worth of a Ph.D. level dissertation.

Appendix A: Ph.D. Qualifying Exam Policy