2025-26

Northeastern University

Department of
Mechanical & Industrial
Engineering

[MIE DOCTORAL QUALIFYING EXAMINATIONS GUIDELINES]

Important information, deadlines, exams selection procedures

Table of Contents

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Doctoral Qualifying Requirements Framework

The goal of the Doctoral Qualifying Examination is to test a student's knowledge in fundamental topics, to gauge the student's potential to conduct independent research, and to provide opportunities for feedback to the student.

The Doctoral Qualifying Examination will be administered by a committee. The exam comprises both a written and an oral portion, with specifics determined by the faculty of each concentration. Complete details for each concentration are provided in the rest of this document.

Upon successfully completing the components in addition to all the necessary coursework, as specified by the student's concentration, the student will be designated as a PhD candidate.

It is the responsibility of the student to adhere to deadlines and coordinate any applicable logistics with their committee.

Mechanical Engineering

Materials Science

Written Exam

The exam will consist of three components:

1) Thermodynamics of materials,
2) Kinetics of phase transformation of materials
3) Structures, defects, and properties of crystalline solids

The disciplinary group will meet after the exam is administered to make a recommendation to the Graduate Affairs Committee (GAC). Either the student will be deemed to have passed the written portion of the exam, or the student will be required to retake one or more components. The disciplinary group will meet again after the retake to assess the performance and make a recommendation to the GAC regarding the retake.

Oral Exam

The oral exam will be given in the Spring semester immediately following the written exam.

The oral exam will evaluate the student's fundamental knowledge in the chosen field of specialization. The oral exam will be administered by a committee formed by the student in consultation with the student's PhD advisor and concentration lead. The student's PhD advisor will chair the committee. The committee will consist of at least two faculty members in addition to the advisor. At least two of the committee members must be tenured/tenure-track faculty members with a primary appointment in MIE. The oral exam committee will provide a list of contents (book chapters, research papers, or other necessary information) that students need to prepare for the oral exam.

Exam Timing

Fall Entry: Students entering the program during the Fall semester are required to take the exam during their second Spring semester in the program. For example, a student entering Fall 2025 will be required to take the exam in Spring 2027.

Spring Entry: Students entering the program during the Spring semester are required to take the exam in the Spring semester two years after their starting semester. For example, a student entering Spring 2025 will be required to take the exam in Spring 2027.

The primary exam will be conducted during the third week of the Spring semester. The makeup exam, if required, will be conducted during the second to last full week of the semester. A student, with the approval of the PhD advisor, may petition for an extension of that timeframe.

Materials Science Engineering (MSE) Topics

Kinetics of phase transformation of materials:

- Scalar and vector fields, fluxes, accumulation and depletion, divergence
- Conserved and non-conserved quantities
- Linear irreversible thermodynamics
- Fluxes and driving forces, entropy production, Onsager's framework, and coefficients
- Diffusion Potential, Onsager's symmetry principle
- Diffusion in chemical solutions, ideal and regular solutions
- Fluxes in lattice and laboratory frames
- Diffusion in binary systems, volume fixed frames, site conservation
- Darken's analysis, interdiffusivity, Kirkendall effect
- Coupling in driving forces, coupling in fluxes
- Mass diffusion under electric fields, thermal gradients, capillarity effects, stress gradients
- Diffusion equation and its solution (scaling laws, separa4on of variables, fundamental solutions, Laplace transform)
- Diffusivity as a function of concentration, function of time (Boltzmann-Matano interface)
- Diffusion mechanisms, random walk, correlation factors
- Diffusion of chains in polymeric systems and solvents, Langevin equation and scaling analyses Motion of dislocations, Peach-Kohler forces
- Motion of free surfaces, nucleation and growth, surface diffusion, attachment-detachment, evaporation-condensation
- Solidification, motion of solid-liquid interfaces, structure and mechanisms, nucleation and growth, governing equations
- Instability and dendritic growth, rapid solidification
- Binary solidification (isomorphous), eutectic transformations
- Order-disorder transformations, order parameter, Landau models for free energy and interfacial systems
- Motion of solid-solid interfaces, crystalline interfaces and grain boundaries, grain boundary structure and kinetics
- Recovery, recrystallization and grain growth

- Precipitation, nucleation, particle coarsening kinetics, Ostwald ripening Eutectoid transformations
- Non-equilibrium transformations (massive, twinning, martensitic, Bainite) Spinodal decomposition
- Polymeric phases, ordering and transformations
- Phase change materials

Thermodynamics of materials:

- Three laws of thermodynamics
- State and path functions (exact and inexact differentials)
- Entropy and Clausius inequalities
- Thermodynamic potentials and Maxwell relations
- Thermochemistry calculations and Hess's law
- Systems and processes (e.g., isothermal, isobaric…)
- Phase equilibria and stability
- Ideal and non-ideal gases
- Behavior of Solutions (Henry and Raoult's laws, Hume-Rothery rules)
- Phase diagrams (single-component and binary systems)
- Statistical thermodynamics (entropy, heat capacity, micro/macrostates, partition function)

Structure, Defects, and Properties of Crystalline Solid:

- Bonding of materials
- Crystal structures
- Atomistic defects in crystalline solids
- Dislocation theory (geometry, energy, and force)
- Dislocation in FCC and Thomson Tetrahedron notation
- Dislocation intersection and multiplication
- Mechanical behavior and strengthening mechanisms
- Fatigue, fracture, and creep
- Connections between atomic-scale structure, microscale structure, and resultant properties in semiconductors, metals, and insulators
- Principles of operation underlying structural characterization techniques (atomic-scale, nanoscale, micron-scale)

Suggested References for Preparation:

[1] Wilkes, P., Solid State Theory in Metallurgy, Cambridge University Press.

[2] Blakemore, J.S., Solid State Physics, 2nd Edition, Cambridge University Press, 1987.
[3] Omar, M., Elementary Solid State Physics: Principles and Applications, 4th Edition, Addison-Wesley.
[4] Porter, D. A. and Easterling, K. E., Phase Transformations in Metals and Alloys, 2nd Edition, Chapman & Hall, London, 1992.
[5] Balluffi, R, Allen,S. M., and Carter, W. C., Kinetics of Materials. Wiley-Interscience, 1st edition, 2005"
[6] Abbaschian, R. and Reed-Hill, R. E., Physical Metallurgy Principles, 3rd Edition, PWS Publishing, Boston, 1992.
[7] Gaskell, D.R., Introduction to the Thermodynamics of Materials, Taylor & Francis.
[8] Hull, D. and Bacon, D.J., Introduction to Dislocations, 4th Edition Butterworth-Heinemann, 2001.
[9] Callister, W.D., and Rethwisch, D.G., Fundamental of Materials Science and Engineering: An Integrated Approach, 4th Edition, John Wiley & Sons, Inc., 2012.
[10] Dieter, G. E,. Mechanical Metallurgy, McGraw-Hill, 1988

Mechanics and Design

Written Exam

The written exam will consist of four components

1) Mechanics of deformable media
2) Dynamics and vibrations
3) Finite elements
4) Engineering mathematics.

The disciplinary group will meet after the exam is administered to make a recommendation to the Graduate Affairs Committee (GAC). Either the student will be deemed to have passed the written portion of the exam, or the student will be required to retake one or more components. The disciplinary group will meet again after the retake to assess the performance and make a recommendation to the GAC regarding the retake.

Oral Exam

The oral exam will be given in the Spring semester following the written exam.

If the student is required to retake any portion of the written exam, the oral exam will be given in the following semester after the student is deemed to have passed the written exam. The oral exam will be administered by a committee formed by the student in consultation with the student's PhD advisor. The student's PhD advisor will chair the committee. The committee will consist of at least two faculty members in addition to the advisor. At least two of the committee members must be tenured/tenure-track faculty members with a primary appointment in MIE.

The committee will provide the student with a small set of journal articles in the student's field of research to study and present. They may be foundational articles of historical and fundamental importance to the field; they may be recent articles on contemporary topics at the forefront of research in the field, or they may be a mixture.

The student will be evaluated based on their ability to synthesize and explain the content of these articles clearly, completely, and concisely. The student will also be expected to demonstrate fundamental technical capabilities in the field — in particular, relating to material covered on the written exam — if required by the committee to do so.

Exam Timing

Fall Entry: Students entering the program during the Fall semester are required to take the exam during their second Spring semester in the program. For example, a student entering in Fall 2025 will be required to take the exam in Spring 2027.

Spring Entry: Students entering the program during the Spring semester are required to take the exam in the Spring semester two years after their starting semester. For example, a student entering in Spring 2025 will be required to take the exam in Spring 2027.

The primary exam will be conducted during the third week of the Spring semester. The makeup exam, if required, will be conducted during the second to last full week of the semester. A student, with the approval of the PhD advisor, may petition for an extension of that timeframe.

Mechatronics

Deliverables

The exam has two deliverables: (1) a written research proposal, and (2) an oral examination of this research proposal in front of a committee of faculty members.

Written Proposal

The proposal is typically 6-8 single-spaced pages in double-column format, similar to a conference paper. The document should lay out a hypothetical research plan that could be carried out over 2-4 years. The proposal should have technical depth and demonstrate an understanding of fundamental tools.

Selecting a Topic

The student is in charge of selecting a research topic for their proposal. They will typically pick a topic and aims related to their current research, but they are also free to propose something else. The chosen topic must be MIE-related with at least two research aims:

1. **First aim:** The first aim may contain background material work that has already been completed/published by the student, such as conference proceedings, journal articles, an MS thesis, or a course project. In such cases, the first aim should also propose new work that builds on this foundation.
2. **Second aim:** The second aim should be more creative, riskier, and more forward-thinking than the first aim. It should be thought-provoking but also balanced with feasibility. The second aim cannot contain work that has already been completed/published by the student.

Any aims inspired/derived by others must be clearly referenced/cited, even if they originated from personal communication.

Oral Examination

The oral examination, which will be held in-person, will last up to 2 hours. The student will present their proposal, including an abbreviated background, research methods, expected outcomes, interpretation, and potential impact. The student should plan for a 30–45 minute talk. The student is expected to have a strong command of the primary literature related to the topic, and material from relevant fundamental courses. The committee members will engage

the student in discussion, ask leading questions, and encourage the student to defend their ideas, explain technical aspects of the proposed methods, and discuss contingencies if things do not work as planned.

Qualifying Exam (QE) Committee

The student is responsible for consulting with their PI to form the QE committee and for coordinating logistics with the committee. The committee is composed based upon the governing rules of MIE qualifying exams. In addition, the student PI or anybody that might have a conflict of interest *cannot* be part of the committee. The committee chair should be an MIE faculty member familiar with the procedures for this exam.

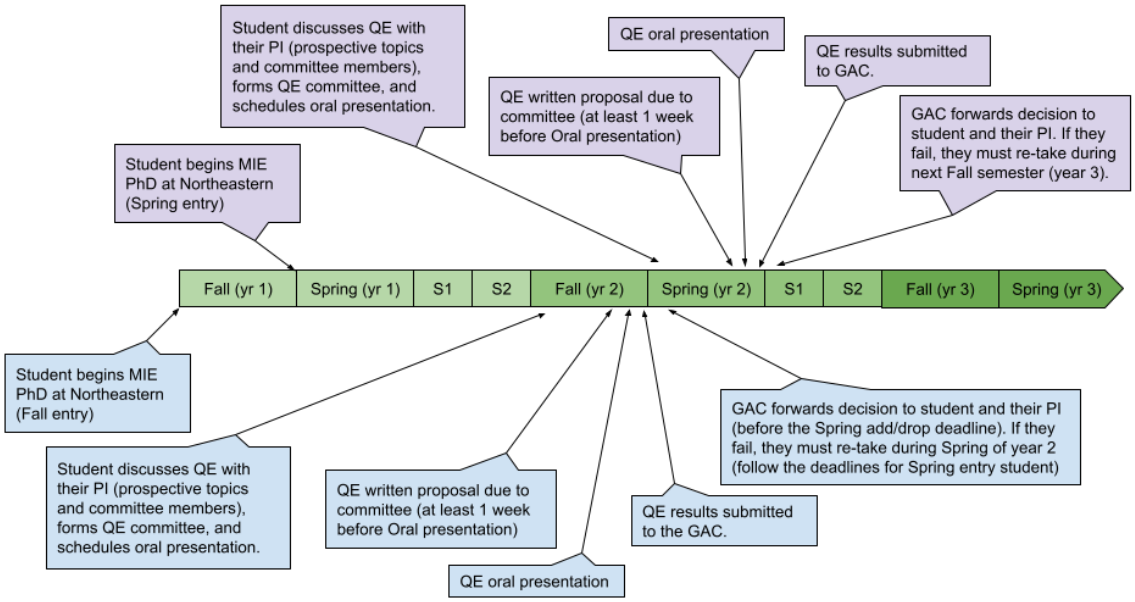
Timing

There are two deadlines every year:

1. **Fall QE:** Student submits form to GAC (includes QE committee, title/abstract, and date of QE) by the end of the second week of classes. The results of QE must be submitted to GAC two Fridays before Thanksgiving recess.
2. **Spring QE:** Student submits form to GAC (includes QE committee, title/abstract, and date of QE) by the end of the second week of classes. The results of QE must be submitted to GAC by the end of the second week of April.

The QE oral presentation can be scheduled at any time during the semester (subject to availability of the committee members). The written proposal is due to the QE committee at least one week before the oral presentation.

A visual depiction of the expected timeline is shown below for a Fall admit (blue) and a Spring admit (purple). All MIE PhD students (applies to both regular and advanced entry) take their QE during their third semester (not including summer).



Outcomes and Feedback

The student and the PI will be informed by the GAC of the outcome. The following criteria will be important for determination of the overall outcome:

- Written proposal
  - Motivation and context
  - Quality of technical writing (clear, concise, organized)
  - Research plan (methods, feasibility, evaluation metrics, innovation/creativity)
    - Aim I
    - Aim II
- Oral presentation
  - Presentation/communication skills (spoken)
  - Organization/structure (visual)
  - Ability to answer questions

Demonstrated knowledge base / relevant technical fundamentals

In addition, the QE committee will provide students with short comments on their strengths and weaknesses in the areas above.

There are three possible outcomes:

- **Pass:** No further work is required. The student should follow MIE guidelines to prepare for their next steps, such as dissertation proposal preparation.
- **Conditional pass:** At the discretion of the GAC, the student will be asked to complete additional tasks in order to pass the exam. The committee will provide a clear explanation of what is expected from the student, along with the expected timeframe.
- **Fail:** A student will receive a fail. Those failing for the first time will be given a set of recommendations and will be expected to retake their exam by the next QE deadline (e.g., Spring 2025 if they failed their QE in Fall 2024). For students failing their QE the 2nd time, the QE committee will recommend to the GAC that the student be dismissed from the MIE PhD program.

Thermofluids

Written Exam

The students are required to choose one of the following options as their written portion of the qualifying exam:

Option 1 – Standard Written Exam: The written exam to be taken in a timeline described in the GAC's guidelines, will consist of four components:

1) Math
2) Thermodynamics
3) Fluid Dynamics *or* Rheology (not both)
4) Heat Transfer

The examination teams will meet after the exam to make a recommendation to the Graduate Affairs Committee (GAC). Possible outcomes include:

1) *Pass* – the student will be deemed to have passed the written portion of the exam
2) *Retake* – the student will be required to retake one or more components
3) *Course remediation* – the student will be required to take/retake a course with a designated satisfactory outcome

In case of a retake, the disciplinary group will meet again after the retake to assess the performance and make a recommendation to the GAC regarding the retake.

Option 2 – Coursework-Based Evaluation: The student will be required to take the following core thermofluids courses and pass all subjects with an overall GPA of 3.5 or better for those courses combined:

- ME 6200: Mathematical Methods for Mechanical Engineers
- ME 7270: General Thermodynamics
- ME 7275: Essentials of Fluid Dynamics
- ME 7285: Heat Conduction and Thermal Radiation *or* ME 7290: Convective Heat Transfer

The final exam and the grading policy of each topic will be reviewed by three (3) subject matter expert faculty selected by the concentration. The students' final exam papers will be collected and regarded as their written qualifier exam of each respective topic, made available to the GAC. The students who select this option as their mode of qualifying examination will have two

full academic years from their start date to complete and satisfy the abovementioned requirements. Upon completion of the requirements, the concentration will make the recommendation to the GAC with the following possible outcomes:

1) *Pass* – the student will be deemed to have passed the written portion of the exam
2) *Retake* – if not received a grade of B+ or better, the student will be required to take the written qualifier exam (Option 1) in corresponding subject(s).

Oral Exam

The oral exam will be given in the Spring semester following the written exam. If the student is required to retake any portion of the written exam, the oral exam will be given in the following semester after the student is deemed to have passed the written exam.

The oral exam will be administered by a committee formed by the student in consultation with the student's PhD advisor. The student's PhD advisor will chair the committee. The committee will consist of at least two other faculty members in addition to the advisor. At least two of the committee members must be tenured/tenure-track faculty members with a primary appointment in MIE.

The committee will provide the student with a small set of journal articles in the area of the student's field of research to study and present. They may be foundational articles of historical and fundamental importance to the field; they may be recent articles on contemporary topics at the forefront of research in the field, or they may be a mixture.

The student will be evaluated based on their ability to synthesize and explain the content of these articles clearly, completely, and concisely. The student will also be expected to demonstrate fundamental technical capabilities in the field — in particular, relating to material covered on the written exam — if required by the committee to do so.

Timing

All students must declare their choice of exam (Option 1 vs. Option 2) by the end of their first semester as a graduate student, and any changes to be made afterwards will require advisor approval and a petition to the concentration. In such case, a panel of "Thermofluids Sciences" faculty will review the petition and make the final recommendation to GAC.

Fall Entry: Students entering the program during the Fall semester are required to take the exam during their second Spring semester in the program. For example, a student entering Fall 2025 will be required to take the exam in Spring 2027.

Spring Entry: Students entering the program during the Spring semester are required to take the exam in the Spring semester two years after their starting the semester. For example, a student entering in Spring 2026 will be required to take the exam in Spring 2028.

The primary exam will be conducted during the third week of the Spring semester. The makeup exam, if required, will be conducted during the second to last full week of the semester. A student, with the approval of the PhD advisor, may petition for an extension of that timeframe.

Thermofluids Engineering (TFS) Option 1 Written Exam Topics

Thermodynamics

- Thermodynamic properties, air and steam tables, compressed liquids, vapor-liquid mixtures, superheated vapors, and ideal gases
- Work and heat interactions
- The first and second laws of thermodynamics and concepts of thermodynamic equilibrium,
- Mass, energy, entropy and exergy balance relations for open and closed systems piston-cylinder devices, closed rigid and flexibles containers, boilers, pumps turbines, compressors, condensers, evaporators, valves, and heat exchangers
- Isothermal, isobaric, adiabatic, isentropic and polytropic processes
- Rankine and Brayton cycles for power generation
- Refrigeration cycles
- Thermodynamics of non-reacting gas mixtures with applications to air-water vapor mixtures for air-conditioning systems

Suggested References for Preparation

[1] Fundamentals of Engineering Thermodynamics, Moran, Shapiro, Boettner and Baily, Wiley Publisher.

[2] Thermodynamics: An Engineering Approach, Cengel and Boles, McGraw-Hill.

[3] Thermodynamics, Turns and Pauley, Cambridge Press.

Fluid Dynamics

- Newton's law of viscosity,
- Hydrostatic pressure distribution and hydrostatic forces on planar and curved surfaces,
- Buoyancy and Archimedes' law,
- Fundamental conservation equations: conservation of mass and energy (1st Law of thermodynamics), linear momentum principle for a control volume,
- Fundamental conservation equations in differential forms, Navier-Stokes, Euler, and Bernoulli's equations in the Cartesian as well as polar coordinate systems, laminar and turbulent flows
- Inviscid (potential) flows, streamline, stream function and velocity potential function.
- Rotational versus ir-rotational flows, vorticity,
- Dimensional analysis and similitude,
- Boundary layer concept,
- Friction factor in pipe flows, Moody chart,
- External flows, flow over a flat plate and over blunt bodies,
- Boundary layer approximation, Blasius equation, Law of the wall,
- Lift and drag coefficients and forces.

Suggested References for Preparation

[1] Fluid Mechanics, White, F.M. & Xue, H., WCB/McGraw-Hill.

[2] Introduction to Fluid Mechanics, Fox, Pritchard and McDonald.

[3] Fluid Mechanics Fundamentals and Applications, Y.A. Cengel and J.M Cimbala, McGraw-Hill.

[4] Mechanics of Fluids, Shames, I.H., Third Edition, 1992, McGraw-Hill.

Heat Transfer

- Fourier equation for the conduction heat transfer rate
- The heat diffusion equation
- Boundary and initial conditions
- Heat conduction in Cartesian and polar coordinate systems, conduction through slabs and composite walls, thermal circuits
- Free and forced convection in internal and external flows, heat transfer from extended surfaces, boundary layer approximations, exact solutions for laminar flows, convective heat transfer correlations, heat exchangers

- Radiative heat transfer, surface radiative properties, view factors, simplified models for radiative heat transfer between two and more surfaces, radiative thermal circuits

Suggested References for Preparation

[1] Introduction to Heat Transfer, Bergman, Lavine, Incropera, and DeWitt, Wiley.
[2] Heat Transfer, J.P Holman, Tenth Edition, 2010, McGraw-Hill.
[3] Heat Transfer, A Basic Approach, M.N. Ozisik, 1985, McGraw-Hill.
[4] Introduction to Heat Transfer, Arpaci, Kao and Selamet, Prentice Hall.

Rheology

- Non-Newtonian vs Newtonian fluid mechanics
- Generalized Newtonian fluids
- Theory of viscoelasticity
- Material functions
- Experimental techniques
- Molecular models
- Polymer physics (melts, solutions...) (Rouse, Zimm, Doi-Edwards)
- Suspensions and emulsions
- Active matter
- Bio fluids
- Phase transitions: liquid vapor; solubility and phase separation; mean field theories, scaling behavior, and Landau approach
- Rubber and gel elasticity
- Non-equilibrium dynamics: diffusion, Langevin equations, fluctuation dissipation relations

Industrial Engineering

Objectives

The PhD Qualifying Exam (QE) is designed to achieve two primary goals:

1. To provide students with an opportunity to deeply engage with a curated collection of significant, high-quality academic papers that are pertinent to the broad scope of their prospective PhD research areas.
2. To assess the students' in-depth understanding of the motivation, design, and methodology of research; quantitative analysis; assumptions; key findings and their implications; and the limitations of the work.

Deliverables

Deliverables: The exam has two deliverables: (1) a written examination and (2) an oral examination with a committee of faculty members.

Process and Timeline for Qualifying Exam

The qualifying exam can be taken in either the Fall or Spring semesters. All MIE PhD students, including both regular and advanced entry students, must take their QE by their third semester, not including the summer.

The summer before you plan to take the qualifying exam, you must email the department to confirm your intent to take the exam. The process and timeline are the same for either semester.

By the second Monday of the Fall/Spring semester, the PhD student must have finalized their QE committee and identified a timeline for their exam. Additionally, at this time, this information must be shared via email with the IE Program Lead.

<u>See the example below:</u>

"Dear Prof. xx,

Working with my advisor, I have constructed the following committee members for my Qualifying Exam: Prof. aa (committee chair), Prof. bb (my research advisor), and Prof. cc. The start date of the exam is mm/dd/yyyy. I will submit my written QE to the committee two weeks later on mm/dd/yyyy. My oral exam is scheduled for mm/dd/yyyy.

Sincerely, IE PhD Student"

On the elected start date for the QE, the committee will provide the PhD student with a set of 4-5 papers, which will serve as the basis of the exam. The set of papers must be communicated to both the student and the IE Program Lead. Among this set, the student should select two exam papers, which will be used in the written and oral exams.

See the example below:

"Dear IE PhD Student and IE Program Lead,

Your written exam component of the qualifying exam starts today, mm/dd/yyyy. As previously discussed, the written QE should be returned to all committee members through email 14 days from now, mm/dd/yyyy. The 4 or 5 papers selected by the committee are: **, **, **, and **. When deciding on your two Select Exam Papers, you must ensure that at least one is from the 'Select Publication Venues' list.

Sincerely, Prof. Xx (committee chair)"

- 14 days following the start date, the PhD student will submit their written examination to the committee.
- 21-28 days following the start date, the committee will administer the oral examination component of the QE, in person or virtually. The oral exam must be scheduled at least 2 weeks prior to the last day of classes in the semester.
- Following the oral examination, the committee members will complete an assessment of the student's performance on the key criteria and submit it to the IE Program Lead and the GAC chair.

- The GAC will review the committee's assessment and make a judgement regarding the QE exam outcome which can be a Pass, Conditional Pass, or a Fail. The GAC will communicate the outcome to the student directly by the end of the semester.

Qualifying Exam Components.

1. Qualifying Exam Committee Formation:

The PhD student will collaborate with their research advisor to form the QE committee of three faculty members. Specifically, the three committee members should be:

1. Committee Chair: The chair of the committee must be a research active MIE faculty member and cannot be the student's research advisor.
2. The student's PhD advisor
3. An additional MIE faculty member

2. Exam Papers Selection

- The committee, after consulting with the PhD advisor, provides a list of **4-5 papers**. After reviewing the set of papers, the PhD student will select two (2) **papers which will be the focus of their examinations, further referred to as the 'selected exam papers'.**
- The papers provided by the committee must be recent (e.g., published within the last 5 years) and feature clear quantitative methodology (e.g., analytical, empirical, modeling and simulation, or experimental design).
- As the purpose is to assess the student's readiness for research broadly, the papers must **not** be ones that the student is already familiar with.
- Additionally, this list should have (i) at least 3 of the papers from the list of "select publication venues" provided below, (ii) not include any papers coauthored by committee members, and (iii) not include any papers used in a previous QE for the student (if it is a retake).
- At least one of the selected exam papers must be from the list of preferred publication venues, defined below.
    - **Select Publication Venues**: All INFORMRS Journals, IISE Transactions, POMS, Science, Nature, Nature Field Journals, PNAS, NeurIPS, AAAI, ICML, ICLR

3. Written Examination:

- After thorough study, review, and analysis of the two selected exam papers, the PhD student should submit an 8–10-page single spaced paper that addresses all of the exam questions listed below. The list of references does not count toward the page limit.
- All work must be completed **independently** by the student without assistance or advisement from any other individuals, including the student's advisor or other students.
- Students are welcome to refer to other related papers (e.g., cited papers, subsequent publications). In alignment with the NU academic honor code, all references used should be appropriately cited.
- Additionally, any use of AI tools should be cited with a description of how the tools were employed.

4. Written Examination Questions:

Analysis and Critical Evaluation (Approx. 2.5-3 pages)

- Provide a concise summary of each paper's main contributions.
- Evaluate the intellectual merit of this work. What makes these studies significant to the field? Consider factors such as the novelty of the approach or findings, the rigor of the methodology, the potential impact on theory or practice, and how the work advances our understanding beyond previous research. Support your assessment with specific examples from the papers.
- Assess the robustness of each paper's experimental design, modeling methodologies, and/or data analysis. What are the primary limitations of each study approach? How might these limitations affect the generalizability of the findings? What are the strengths and weaknesses of the methods used?

Methods and Models (Approx. 1.5 - 2 pages)

- Choose one key mathematical model, statistical method, or analytical framework from either paper. Explain its underlying principles and justify why it was appropriate for addressing the research question.

Assumptions (Approx. 1.5 - 2 pages)

- Critically evaluate the key assumptions made in each paper. Discuss how these assumptions shape (i) the analytical approach and (ii) the conclusions or results. Are these assumptions reasonable and well-justified given the research context?

- Identify any assumptions that seem questionable or overly restrictive. How might violations of these assumptions affect the validity of the results?

Future Research Directions (Approx. 2.5 - 3 pages)

- Discuss how the two papers are interrelated. Based on this interrelationship, and gaps or questions raised by both papers, propose two specific research questions that would advance this field. The research questions should be related to both papers.
- For each question, outline a research strategy including methodology, potential challenges, and expected contributions. Justify your methodological choices and explain how your study would address limitations in the current work.

5. Oral Examination:

- The oral examination is an opportunity for the student to demonstrate the depth of their understanding and their ability to engage in scholarly conversation about complex research topics.
- The 1.5-hour exam will consist of the committee posing interactive questions about the two papers the student has selected for in-depth discussion and focused on in their written examination. The oral exam is not intended to be a presentation given by the student.
- Students should come to the oral exam thoroughly familiar with both papers and ready to discuss all aspects of the written examination content in greater detail. They should be prepared to think on their feet and engage in academic discourse about the research, conclusions, and potential implications or extensions of the work.
- This session also serves as a platform for the committee to assess the student's foundational knowledge in areas pertinent to the chosen papers. To facilitate their responses, students are permitted to reference the original papers, slides, and notes they have prepared in advance.

6. Examination Evaluation and Assessment:

- The student's performance in both the written exam and oral exam will be assessed at the end of the oral exam. At the conclusion of the oral exam, the chair of the committee will submit a written evaluation of the student's performance using a standard form/rubric to the GAC.
- The evaluation will assess the student's critical understanding of the literature, deep understanding of the context and technical sections of the papers, their ability to engage in a scholarly discussion during the oral examination, and their ability to identify novel research questions and plans.

7. Outcomes and Feedback:

Following the GAC's review and evaluation of the committee's assessment, there are three possible outcomes.

- **Pass:** No further work is required. The student should follow MIE guidelines to prepare for the next steps, such as the dissertation proposal preparation.
- **Conditional Pass:** At the discretion of the GAC, the student will be asked to complete additional tasks in order to pass the exam. The GAC will provide a clear explanation of what is expected from the student, along with the expected timeframe for meeting these expectations.
- **Fail:** A student receiving a failing score for the first time will be given a set of recommendations and will be expected to retake their exam, including both the written and oral components, in the next QE semester (e.g., Spring 2026 if failed in Fall 2025). For students failing the QE for the second time, the GAC will recommend that the student be dismissed from the MIE PhD program.

How to Register

Qualifying exam registration instructions for the 2025-2026 academic year will be due online, August 1st, 2025. If you entered your PhD program in **2025 or earlier,** you must register for the qualifying exam with your advisor's approval.

Click Here to Register by August 1st, 2025: Link to Register for Qualifying Exams

It is the responsibility of the student to adhere to deadlines and coordinate any applicable logistics with their committee.

For questions regarding registration, please contact Necol Sosa at n.sosa@northeastern.edu