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Investigating Preliminary Examination Practices in U.S. Mechanical Engineering Doctoral Programs

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This study investigates mechanical engineering PhD preliminary examinations in the U.S. to identify the evaluation methods used during the initial years of students' academic tenure. While methods for evaluating early-stage PhD students in mechanical engineering vary widely, there is a notable lack of research on the goals, assessment strategies, and outcomes associated with these different evaluation methods. This gap underscores the need for a deeper understanding of effective and inclusive assessment techniques. By characterizing the various preliminary examination techniques used across a sample of 25 mechanical engineering doctoral programs, we aim to identify common practices and their underlying educational goals. Our research evaluates the examination techniques used by the programs, categorizing them by the methods utilized, such as course-based completion requirements, written and oral fundamental exams, and preliminary research proposals. Next, for programs with specific exam topics, we reviewed these categories to identify trends in doctoral programs' organization and descriptions of fundamental mechanical engineering knowledge. Ultimately, we found a wide range of examination techniques and requirements. Notably, 16 of the 25 programs offered some form of flexibility for students to select the knowledge which they were expected to master. We hope this work can provide a clearer understanding of the early-stage examination practices in U.S. mechanical engineering programs. Characterizing evaluation methods can guide curriculum improvements and pedagogical strategies across universities, ultimately offering insights into early-stage doctoral examinations to better prepare researchers and practitioners in mechanical engineering.

Keywords: preliminary examination, doctoral education, mechanical engineering

1 Introduction

Doctoral programs in mechanical engineering aim to develop advanced technical expertise and research skills, preparing graduates for careers in academia, industry, and research organizations. These programs focus on both the mastery of core engineering principles and the development of independent research capabilities. Students are expected to engage in original research that contributes to the advancement of the field, while also demonstrating comprehensive knowledge in one or more fundamental areas of mechanical engineering, such as thermodynamics, solid mechanics, fluid dynamics, control systems, and design.

During a doctoral program, students undergo a critical shift from acquiring knowledge to generating it—a shift from the "known" to "unknown." Successful doctoral students learn to navigate the uncertainties of the "unknown," identifying research gaps and designing and executing methodologies to address them. Early-stage exams, such as the *preliminary exam* (also referred to as the "qualifying exam" or "comprehensive exam"), are key milestones in this journey, evaluating a student's progress during this transition, typically within the first one to two years of their program.

Despite the importance of early-stage examination, there is limited research focused on the specific techniques used and topics evaluated in mechanical engineering doctoral programs. To the best of our knowledge, there is no prior work synthesizing and comparing preliminary examination practices across multiple mechanical engineering programs. Understanding the various examination techniques—such as written exams, oral evaluations, and fundamental knowledge assessments—could provide valuable insights into how doctoral programs are administered. This study aims to fill this gap by evaluating and synthesizing the preliminary examination techniques used by 25 mechanical engineering doctoral programs in the United States.

2 Background

The time required to complete a Ph.D. in mechanical engineering varies—typically 4-6 years. During this time, course completion and exams serve as key milestones in assessing a student's progress. Broadly speaking, these milestones can be divided into multiple phases: early-stage evaluations, later-stage prospectus, and final dissertation defense. Early-stage evaluations may include successful completion of course requirements, as well as written, and/or oral preliminary exams focused on evaluating the student's mastery of fundamental knowledge and their preparedness to undertake dissertation-level research. Preliminary exams are used to confirm that students have the necessary foundation to progress to the research phase of their program and are sometimes associated with advancement from "Ph.D. Student" to "Ph.D. Candidate."

In his book, *The Graduate School Mess*, Leonard Cassuto explained that preliminary exams were introduced in the mid-20th century to address the post-WWII surge in Ph.D. students, which led to a perception of "mass-produced" dissertations. During this time, the dissertation defense, which was previously the only form of examination, evolved into a formality, much like it is today. Institutions saw a need for earlier "barrier exams" to maintain academic rigor and control quality [1]. Recent studies have identified three primary purposes of preliminary exams: (1) serve as a subject matter assessment, (2) support students' development as independent scholars, and (3) gatekeeping to determine who should be allowed to continue in their studies [2]. However, many critiques over the lack of intention and clear purposes of preliminary exams exist [3]. Some scholars advocate for the elimination of preliminary examinations altogether, citing equity concerns [4]. Others have suggested alternative assessments of a students' research preparedness, such as coursework completion and proposal writing [2].

From the student's perspective, the preliminary exam represents a critical institutional milestone that serves to validate their status and legitimacy as a doctoral candidate. Given that pursuing a

Ph.D. is often deeply tied to one's personal and professional identity [5], these exams are perceived as significant and sometimes daunting barriers. Indeed, studies have remarked on the immense pressure, anxiety, and even dread students feel when working to earn this validation [6]. From the faculty and staff's perspective, designing, administering, and evaluating preliminary exams can be a time-intensive process. Despite the personal and institutional impact of early-stage assessments, the topic remains significantly underexplored. This gap is particularly evident in the field of mechanical engineering, emphasizing the need for research and attention.

3 Methods

The choice of which mechanical engineering programs to include in the sample for this study of preliminary examination techniques was largely determined by availability of data and rankings based on number and percentages of doctoral degrees granted to groups of specific interest. The popularity of the US News and World Report rankings [7] for students choosing which schools to attend was one potential system for determining our sample, but knowing the influence of reputation and marketing campaigns on these rankings at the department level, as well as the lack of access to the full ranked list of top mechanical engineering doctoral degree granting institutions dissuaded our use of this database. We were also initially interested in studying mechanical engineering programs with an explicit design focus but thought to broaden our sample by incorporating mechanical engineering programs that both include or exclude design as an explicit topical focus area within their official processes for students working towards a doctoral degree.

The ASEE report *Profiles of Engineering and Engineering Technology, 2021* [8] was accessible, reliable and useful in determining our sample as the report directly lists the top doctoral degree granting engineering schools nationwide by number of graduates, as well as the top doctoral degree granting engineering schools based on percentage of women and percentage of under-represented minority (URM) students. Our initial sample thus included the top 20 doctoral degree granting engineering institutions based on number of graduates, the top 5 doctoral degree granting institutions based on percentage of women graduates, and the top 10 doctoral degree granting institutions based on percentage of URM graduates. We also included our own institution and multiple schools in our region (Western U.S.) for the sake of local comparison, summing to 35 institutions for our initial sample.

For each institution on our list, we investigated the websites for the mechanical engineering programs specifically as well as the associated graduate school policies and relevant program graduate handbooks, where necessary. For institutions actively granting doctoral degrees in mechanical engineering, we attempted to ascertain the information shown in Table 1 from publicly available information on official websites.

Table 1: List of data gathered (when available) for each institution in this study.

Information gathered	
Institution name	Timing of exam (when exam is administered during a doctoral degree program)
Degree program name	Frequency of exam administration
Number of faculty	Number of set topics / topic areas
Number of doctoral students	Number of topics students tested on
Name given to assessment of doctoral students within first ~2 years of the program (e.g., preliminary exam, qualifying exam)	List of topics
	Additional topic details
Official definition of exam	Date data updated
Format of exam	URL

Overall, our data collection was guided by our fundamental research question: **How do mechanical engineering doctoral programs conduct preliminary examinations?** As the first several institutions examined in our sample demonstrated considerable breadth and variation in terms of exam formats and topics included, we also explored a second research question regarding the use of topical exams as part of a preliminary examination process, namely: **For mechanical engineering preliminary examinations that feature topical exams, what are the topics?**

Data analysis was an iterative process with partial overlap with data collection, as we discussed early similarities and differences as points of interest while examining institution websites. Several of the institutions on the initial list did not grant doctoral degrees specifically in mechanical engineering and were eliminated from the sample. Detailed information for several institutions was unavailable, leading those programs to also be stricken from our final dataset. Overall, we were able to investigate 25 doctoral degree granting programs in detail to understand and characterize their mechanical engineering preliminary examination processes. The list of the 25 institutions included in our dataset is available in Table 2. Once data were collected for all institutions in our sample, a secondary classification process was utilized to bin the institutions based on types of assessment utilized in preliminary examinations, to develop counts of specific topics used in topical exams, and to roughly categorize the intended purposes of each assessment.

3.1 Limitations

The 25 institutions that comprise our final sample are not representative of all mechanical engineering doctoral programs but provide a breadth of examples of how preliminary examinations are administered nationwide. Because of our use of rankings based on the ASEE report *Profiles of Engineering and Engineering Technology, 2021* [8], our sample is skewed towards institutions that graduate large numbers of engineering doctoral students, or a significant percentage of women and underrepresented minority doctoral students. As the goal of the study is to understand how preliminary exams are administered in mechanical engineering doctoral programs, we see the overlap in examination practices among the institutions in our dataset as

Table 2: List of institutions granting doctoral degrees in mechanical engineering examined as part of this study.

Name	
Carnegie Mellon University	University of California San Diego
Colorado State University	University of Colorado Boulder
Cornell University	University of Florida
Georgia Institute of Technology	University of Illinois Urbana-Champaign
John Hopkins University	University of Maryland
Massachusetts Institute of Technology	University of Michigan
Ohio State University	University of Minnesota
Pennsylvania State University	University of Northern Arizona
Purdue University	University of Puerto Rico
Stanford University	University of Texas Austin
Tuskegee University	University of Texas El Paso
University of California Berkeley	Virginia Polytechnic Institute and State University
University of California Los Angeles	

indicators of saturation, as the primary examination methods remain similar from program to program with variations in the details of topic areas, formats, and timing. Future work with a larger dataset, with particular focus on small institutions or regions not well represented in our current sample could add to our corpus of data and ensure that our broad sampling approach does not obscure additional differences and variations in preliminary exam practices.

3.2 Positionality

We (the authors) are faculty within a mechanical engineering department at an R1 institution with very high research activity. We both hold doctoral degrees, one in mechanical engineering and one in design science. During our studies, we experienced different formats of preliminary examinations and degree course requirements. The lead author is an early career tenure-track faculty who serves on the graduate committee, an internal departmental standing committee charged with administering, developing, and updating preliminary examination processes for the department (among many other tasks). The second author is a mid-career instructional faculty member who also chairs the mechanical engineering department's standing diversity, equity, and inclusion committee. In this capacity the second author is an accessible touchpoint for students with equity concerns about assessments and other academic processes, including the preliminary examinations. We are thus interested in understanding more about nationwide mechanical engineering preliminary examination practices in order to advocate for change in how we conduct these assessments in our department.

4 Results

Across our sample of 25 mechanical engineering doctoral programs, we identified a wide range of topics and techniques for assessment. All programs in our sample required coursework completion, though the criteria varied in content and structure. Beyond coursework, programs implemented two primary forms of examinations: assessing fundamental knowledge and evaluating research readiness. While a small subset of programs (5, 20%) conducted both types of exams separately, most (20, 80%) required only one, often integrating elements of both assessments and/or relying on coursework completion to indicate mastery of topical content. Approximately half of the programs (14, 56%) defined specific subject areas for fundamental knowledge exams, with each program identifying between 3-15 topics. These topics varied, with only fluid mechanics and dynamics being included across all 14 programs with specified topic areas.

4.1 Overarching goals of preliminary exams in mechanical engineering

Overwhelmingly, the goal of preliminary exams in mechanical engineering doctoral programs was to assess a student's "proficiency" and "mastery" of technical topics. However, programs defined these technical topics very differently across our sample. Many of the programs provided prescriptive topics for students to master, which often aligned with specific material from upper-division undergraduate courses and/or first-year graduate courses. Other programs provided more flexibility in assessing a student's knowledge, indicating that the preliminary exam evaluated only the underlying theory specific to their dissertation topic. Programs that focused examination on dissertation topics typically indicated specific course completion requirements, which ranged from successful completion of two graduate-level classes to completing the requirements for a master's degree.

We identified additional goals of preliminary exams, including to evaluate a student's analytical skills, ability to synthesize literature, and aptitude for communicating technical knowledge. Only one program explicitly stated that a primary objective of their preliminary exam was to identify areas for the student to focus on strengthening during their remaining graduate studies. Many described the preliminary exam as "supporting the development" of a student, indicating that the process of preparing for and completing the exam was just as important as simply passing it. Nearly all programs described preliminary exams as a "gate:" if a student does not pass in the first 1-2 attempts, they cannot continue in their program.

Programs referred to early-stage exams as either "Qualifying Exams" or "Preliminary Exams." We found no convincing differences in the techniques or objectives associated with each term; these labels appeared to be used interchangeably. As graduate handbooks and public websites constituted the bulk of our dataset, the information was largely operational, intended for current students, staff, and faculty to understand practical guidelines and logistical considerations for the administration of preliminary exams. The theoretical or philosophical underpinnings of these processes may be present in internal department records but were difficult to locate for this analysis and are thus not represented in these findings.

4.2 Topical areas of fundamental knowledge in mechanical engineering

Fourteen programs—representing approximately half (56%) of the total sample—identified specific topic areas, often referred to as "fundamental areas," from which students must choose to demonstrate mastery of foundational knowledge. It is important to note that these areas sometimes differed from the departments' advertised "research focus areas," which sometimes included broader applications of mechanical engineering (e.g., intelligent systems, air quality, automotive). Table 3 presents the full list of fundamental knowledge topics identified across this sub-set of 14 programs. Of the programs with defined topics for fundamental knowledge exams, five (20%) included an interdisciplinary or flexible option that could be defined by the student and advisor. The number of specific areas within each mechanical engineering department ranged from 3-15. Only two topics, fluid mechanics and dynamics, were included in all fourteen programs.

Table 3: Fundamental knowledge exam topics and the numbers of programs identified across fourteen programs with defined topical areas.

Topic Area	#	Topic Area	#
Fluid mechanics	14	Mathematics	5
Dynamics*	14	Biosystems / bioengineering	5
Solid Mechanics	13	*Interdisciplinary (flexible option)*	5
Controls	12	Nanoscience / nanoengineering	3
Design	11	Computational sciences	3
Heat transfer	10	MEMS	2
Thermodynamics	9	Nuclear and radiation	1
Manufacturing	8	Aero structures	1
Materials	8	Energy systems	1

**Included a topic on "Vibrations and acoustics"*

4.3 Techniques for evaluating early-stage doctoral candidates

We identified multiple assessment techniques, types, and formats of mechanical engineering preliminary examinations (Table 4). All 25 programs in our sample required course completion with varying criteria (e.g., GPA requirements, specific versus flexible course plans) as part of their evaluation process. All but one program (24, 96%) conducted a preliminary exam outside of coursework. Our analysis identified two primary types of examinations: (1) Mastery of fundamental knowledge and (2) Evaluation of research readiness. Five programs (20%) conducted both types of exams independently of coursework, typically spaced 6–12 months apart between the students' first and third years. The majority of programs (19, 76%) required only one type of exam outside of coursework, focusing either on fundamental knowledge, research readiness, or combination of both.

Table 4: Summary of mechanical engineering preliminary examination techniques, types, and formats.

Assessment techniques	
Coursework completion (25, 100%)	Required GPAs for specific courses (ranged from 2 courses to completed MS requirements)
Preliminary examination (24, 96%)	Out-of-class exam administered by evaluation committee
Preliminary examination types	
Fundamental knowledge assessment (16, 64%)	Assessment of a student's mastery of mechanical engineering principles and foundational knowledge
Research readiness assessment (13, 52%)	Evaluation of a student's comprehension of their research topic and potential to successfully conduct research on that subject matter
Preliminary examination formats	
Written research report and/or oral defense (12, 48%)	1-50 page prepared summary and/or literature review of research topic; most often accompanied with 0.5-2 hour oral defense
Oral topical exam (6, 24%)	0.5-2 hour interactive evaluation in which a student answers or solves questions posed by a panel of examiners, most often without the aid of external materials or prepared resources
Written topical exam (6, 24%)	0.5-4 hour assessment requiring students to solve problems in a supervised, written format
Paper critique exam (3, 12%)	Students provided with 1-3 technical publications 1-2 weeks in advance of an oral evaluation of the student's understanding of the paper(s)
Format variation across focus-areas (2, 8%)	Programs with different examination formats depending on the focus area (e.g., paper critique for 'design' and oral topical exam for 'fluid dynamics')

4.3.1 Examining fundamental knowledge

Sixteen programs (64%) administered *fundamental exams*, which we defined as assessments of a student's mastery of core mechanical engineering principles, conducted independently of coursework requirements. The remaining programs often indicated that coursework was the primary evaluation of fundamental knowledge mastery or that fundamental principles should be evaluated during a research readiness exam. Fundamental exams were most frequently administered by a committee of faculty, which varied in size and composition. Some programs explicitly required the student's primary advisor to participate on the evaluation committee while others forbade it. Some programs required a "silent observer" to be present on the committee; their role was to ensure fair treatment of the student during the exam.

The most frequent fundamental exam types that we identified were *oral* and *written.* An *oral topical exam* (6, 24%) was defined as a live, interactive evaluation in which a student answers or solves questions posed by a panel of examiners, most often without the aid of external materials or prepared resources. The duration and number of topics covered during these exams ranged from 0.5-2 hours and 1-4 topic areas, respectively. Meanwhile, a *written topical exam* (6, 24%) was defined as timed assessments requiring students to answer questions or solve problems in a supervised, written format. The duration of these exams varied, ranging from 1 to 5 hours, and followed either a closed- or open-note format, depending on the program's policies.

Three programs (12%) administered *paper critique exams*, which we defined as a live, oral evaluation of a student's understanding of prior literature. Students were given specific technical publication(s) 1-2 weeks prior to their exam date. During the exam, a panel of examiners asked the students questions regarding technical contents, the research methods used, literature synthesized (i.e., literature cited by the paper), and future potential research directions. All three programs allowed students to bring prepared notes or written summaries for their exam.

Two programs (8%) administered different formats of fundamental exams across their department's focus areas. For example, one department's "design," "dynamics," and "thermal fluids" committees administered paper critique exam formats, while the "nuclear" committee administered a written exam format.

4.3.2 Examining research readiness

Thirteen programs (52%) conducted *research readiness exams*, defined as written and oral evaluations of a student's comprehension of their research topic and potential to successfully conduct research on that subject matter. The examination committee sought to evaluate various concepts, including the student's familiarity with prior literature and understanding of the underlying theories and methodologies relevant to their dissertation research. The examination committee also assessed the student's ability to communicate technical concepts effectively in both written and oral formats, answer relevant questions, and respond to critiques. The examination committee always included the student's primary advisor. Some programs also required an "unbiased" or "neutral party" to be present to ensure fairness and proper procedures were followed.

Many programs broadly described the goal of this exam format to evaluate the skills and knowledge required for successful graduate-level research. Of the thirteen programs, eleven used both a written and oral format, while two only used an oral-only format. For the written component, program requirements varied from a 1-page abstract to a 50-page literature review or first-author technical publication.

Of note, eight of these thirteen programs only conducted research readiness exams and relied on students' course completion as their primary method for evaluating students' mastery of fundamental knowledge.

5 Discussion

In examining how mechanical engineering doctoral programs conduct preliminary examinations, we have uncovered extensive variation in what these examinations are called, when they are administered, how they are administered, what they cover, and multiple other dimensions of difference across our limited sample. There is no single standard or format for these assessments, and at some institutions the examination processes are also subject to change over time as faculty and administration adapt and evolve. In other words, there is no single answer to our fundamental research question of “How do mechanical engineering doctoral programs conduct preliminary examinations?” rather there exists a spectrum of responses.

5.1 Variation in exam topics, techniques, and program structure

While mechanical engineering as a codified, named discipline has existed since the 1800s [9], [10], it is eye-opening that today’s mechanical engineering programs do not have a standard set of topic areas consistent from institution to institution. Instead, flexibility in fundamental knowledge is the primary pattern, as there is considerable variation in how topics are listed, their resolution and number, and what is included as required knowledge for mechanical engineering doctoral students. Specifically from our dataset, it is notable that 11 programs do not require students to name specific topical areas outside of coursework completion. Furthermore, 5 of the 14 programs that do require topical focus areas as part of the preliminary examination also feature an “interdisciplinary” or “flexible” option as a topic, emphasizing the flexibility and breadth in the topic areas that are recognized as mechanical engineering fundamental knowledge. In total, 16 out of 25 programs in our sample provide flexibility to students with respect to the types of fundamental knowledge they are expected to master. Relatedly, 11 out of the 25 programs in our sample included “design” as a fundamental knowledge topic area that doctoral students could choose for targeted assessment. As design has been referred to in engineering education as the “the central or distinguishing activity of engineering” [11], it is notable that the majority of mechanical engineering programs in our sample do not claim it as a foundational topic area for doctoral students to demonstrate their content mastery.

Across our sample, it is also important to note that these examination processes are heavily contextual, informed by national trends, institutional characteristics (and related programs), faculty resources, and changes to student learning and developmental needs. If data were collected longitudinally across decades, it is likely that many changes would be evident as mechanical engineering graduate programs have adapted to new technologies, emerging fields, and modern theories of teaching and learning.

5.2 Known to unknown transition

As highlighted by the sample data, despite the variation in what these assessments are called by various programs, nearly all mechanical engineering programs do some form of assessment to verify that doctoral students demonstrate mastery of fundamental knowledge and are ready to undertake independent research. In this way, the preliminary examination is an important milestone along a students' progression from working with known phenomena towards exploring the unknown. As doctoral research, and specifically the dissertation, is an individual student's formal contribution to the existing academic body of knowledge, the preliminary examination scaffolds students' development towards comfort with the unknown and forays into creating new knowledge.

5.3 Mechanical engineering as an interdisciplinary field

Variation in the fundamental topics regarded as central to mechanical engineering highlights the inherently interdisciplinary character of the discipline. Mechanical engineering is colloquially known as one of the broadest fields of engineering, spanning methodologies, applications, materials, and industries [12]. As it has adapted from its early foundations, the field has grown to encompass and spawn related disciplines including biomedical engineering, robotics, materials science, environmental engineering, and many more. More recently, the field has expanded to include knowledge from the humanities and social sciences to support the exploration of human- and societal-dimensions of engineering [13], [14].

In considering mechanical engineering as fundamentally interdisciplinary, it is interesting to compare preliminary examination formats in mechanical engineering with formats of fields known to be interdisciplinary, such as engineering education and design. Self-described interdisciplinary engineering doctoral programs also feature considerable variability across preliminary examination formats and topics, with even greater emphasis on customizability for students. In our modern and globalized world, engineering doctoral students are increasingly interested and required to address complex problems that require interdisciplinary skills and knowledge [15]. Customization of evaluation may especially support the development of students working on boundary topics that require knowledge from multiple disciplines. Customization and individual tailoring to create meaningful assessments are also suggested by those advocating for increasing equity in graduate education [2], [3].

5.4 Individualization and equity considerations

The incorporation of greater flexibility and the category of "interdisciplinary" and "flexible" as legitimate topic areas within mechanical engineering suggests a movement in the field towards more a more customizable view of what constitutes fundamental knowledge for doctoral students. This shift towards greater customization and personalization also reflects the potential for more equitable assessment in preliminary examination formats, as movement away from a one-size-fits-all standard exam model to instead flexible and unique exam strategies suggests that accommodations for student differences can be recognized rather than ignored or hidden. As the journey to complete a doctoral degree is undoubtedly personal and one-of-a-kind, incorporating personalization in each step of doctoral examination is consistent with the desired eventual specialization in individual research output.

The emphasis on making preliminary examinations in mechanical engineering programs more equitable is also apparent in oral exam formats as well, as several programs have incorporated the role of a "silent observer" or presence of a neutral party, aside from the doctoral student and examination committee, as another means of attempting to increase fairness when assessing research readiness or fundamental knowledge through real-time interaction. While well-intended, the incorporation of an additional person during the preliminary exam process is another resource implicated in the administration of the assessment, which can already be a resource-intensive process. Anecdotally, many faculty and staff are frustrated at the time-intensive nature of preliminary exams, as regardless of format the assessments must be designed, administered, graded, and results formally communicated to students and graduate programs, with considerable supporting infrastructure and logistics. Some programs may choose to keep exam formats in place that are suboptimal from an educational assessment standpoint but are simpler to execute for resource-limited faculty and staff. Change always requires effort, so some programs may choose to stick with historical exam formats and options rather than remodeling or updating preliminary examination processes.

6 Conclusion

This study looked across 25 mechanical engineering departments granting doctoral degrees to understand their processes for administering a preliminary (or qualifying) exam to determine students' readiness and aptitude for proceeding in their doctoral education. Generally given within the first two years of a doctoral program, these exams featured considerable variation in name, format, timing, and purpose across our dataset. All 25 programs examined included course completion with specific criteria as part of the examination process. Nearly all programs (24) included assessments intended to gauge either fundamental content knowledge and/or research readiness for doctoral students. There was considerable variation of topic areas considered fundamental to mechanical engineering departments in both name and number, as some programs listed three fundamental topic areas and others listed as many as fifteen. Similarly, there were multiple formats for conducting assessments of fundamental content knowledge, including oral exams, written exams, paper critique exams, or some mixture of these formats. About half of the programs included in this study required a specific research readiness assessment, which included oral and/or written components to demonstrate a doctoral students' ability and potential to successfully conduct graduate-level research.

The tremendous variation across the dataset regarding formats and topics included as part of the preliminary examination process in mechanical engineering programs suggests that the field is anything but homogeneous. Future work examining how individual staff, faculty, and students feel about the efficacy and appropriateness of these types of preliminary examinations could yield greater insight as to the experiences and beliefs of those implicated in these processes, as could expanding the dataset to include more institutions. As a foray into understanding the range of preliminary examination techniques in mechanical engineering programs today, this paper demonstrates the wide range of fundamental topic areas in mechanical engineering and differences in how doctoral students are required to demonstrate suitable preparation for advanced research through the format of a preliminary examination.

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