Incorporating Industry-Sponsored Technical Writing into Engineering Laboratories

Caleb Levi Head, University of Arkansas at Little Rock

Caleb Head earned a Bachelor of Science in Mechanical Engineering from the University of Arkansas at Little Rock in 2022. He is pursuing a Master of Science in Mechanical Engineering at the University of Arkansas at Little Rock with a research focus on engineering education. With a passion for teaching engineering courses, he intends to pursue a Ph.D. in Engineering Education after completing his master's program to contribute to research and pedagogy in the field, to become a professor, and to advance engineering education practices.

Dr. Lawrence E. Whitman P.E., Kennesaw State University

Dr. Lawrence Whitman is Dean of the Southern Polytechnic College of Engineering and Engineering Technology.

Dr. Whitman earned his Bachelor's degree in Mechanical Engineering Design Technology from Oklahoma State University where he also earned his Master

Dr. Srikanth B Pidugu P.E., University of Arkansas at Little Rock

Dr. Pidugu is Director (Interim) and Professor of School of Engineering & Engineering Technology at University of Arkansas at Little Rock. He obtained Ph.D. in Mechanical Engineering at Old Dominion University in 2001.

Incorporating Industry-Sponsored Technical Writing into Engineering Laboratories

Introduction

Laboratories are critical courses within engineering curricula because they allow students to bridge the gaps between conceptual knowledge and practical applications. For example, the materials testing laboratories in mechanical engineering programs allow students to find material properties and safely test components before finalizing designs [1]. In 2022, ABET released updated criteria for accredited programs from 2023-2024. Under criterion 3, ABET notes that students should be able to solve complex problems, apply design to produce solutions, effectively communicate with a range of audiences, recognize professional responsibilities, function effectively on a team, develop and conduct appropriate experimentation, and analyze and interpret data [2]. An engineer must proficiently demonstrate these skills upon graduation, and it is necessary to equip the student with resources and a curriculum to learn practical communication skills.

The typical engineer will spend one-third to one-half of their working day writing reports, and the engineering curriculum should prepare students for such tasks [3, 4]. Despite the recognized importance of technical writing, students often struggle due to a disconnect between academic instruction and industry expectations. This research project collaborates with industry partners who are members of the advisory board, faculty, and campus research facilities. It aims to bridge this gap by integrating industry-standard technical writing templates into laboratory assignments and leveraging collaborations with industry professionals. By doing so, the study seeks to enhance technical writing skills, better prepare students for their engineering careers, and ensure alignment with ABET accreditation.

The research presented in this paper comes from the pilot study conducted in the fall 2024 semester in a senior-level mechanical engineering fluids laboratory. The objective of the pilot study was to successfully collect informed consent from students, modify existing laboratory templates for students to use for assignments, and gather feedback from the students regarding the study process. This work will influence the main study conducted in 2025, where practices such as peer review and assignment editing/revision will be implemented in a senior-level mechanical engineering materials testing laboratory.

Literature Review

The literature review covers four main topics: the definition and importance of technical writing, proposed solutions in the engineering curricula, the importance of laboratories in engineering education, and industrial collaboration in the engineering curricula.

Technical Writing: Definition & Importance

Blickle and Passe broadly describe technical writing as “writing which deals with subject matter in science, engineering, and business.” [5]. Of the two styles of thought, associative and sequential, technical writing falls into the latter category because it aims to produce a logical, sequential thought that minimizes ambiguity. Brooks and Warren highlight that technical writing deploys "specialization of language for the purpose of precision" with an end goal of "absolute precision." [6]. W. Earl Britton proposes that technical writing is valid only if the reader can only derive one meaning from the work [5].

A lack of understanding in technical writing has been demonstrated in engineering and other fields, where "many undergraduate and graduate students understand neither the process of scientific writing nor the significance of peer review." [3] It is commonly believed that these struggles originated in high school education, where writing was not used to cover technical topics but to apply associative thought processes to the literature covered in the curriculum. It is important to note that deficient skills must be treated by company-based professional development to bring employees up to the levels necessary to fulfill the responsibilities of their roles [7].

Technical Writing: Proposed Solutions

Universities have tackled this issue by numerous methods, each to their degrees of success. Examples include technical writing requirements in the engineering degree plans, both as a lecture [8] and as a laboratory [9]. There are also works of interdepartmental collaboration at the university level between engineering and English departments [10], and implementations in the classroom at the formal assignment level and informal level for individual assessment and communication [11]. These courses would range from freshman-level courses to senior-design [12]. Peer review has also been implemented so that students can review each other's assignments before the final submission [11].

D.A. Winsor published a statistic that novice engineers were tasked with documenting their work experience in technical writing and the methods they had learned to do so [13]. The table below gives an excellent summary of the most common and effective methods found among the 190 engineers who were surveyed. An important statement from her findings is, "Students indicate that a typical learning pattern is to use models and seek advice from coworkers when preparing drafts, submit the draft to a supervisor, and use the supervisor's feedback to revise." [13] This suggests that effective technical writing education is most effective when the learning process emulates the practices found in industrial settings.

Method of Learning	Percentage Cited
Use of Models	53%
Editing from supervisors	38%
Editing from co-workers	24%
Freshman college technical writing course	14%
High school courses	7%
Professional Development at Work	5%
Work evaluations	5%

Table 1, Cited methods of learning among senior-level engineering students.
Statistics extracted from [13].

It is important to note that while the use of models was the highest cited in Winsor's survey, there were counterpoints that bring up the negatives of dependence on models, as students do not gain the same experiences when depending on models, and may even produce sub-par work [14]. This counterpoint has been explained by others, however, as a means of exposure to careers where "cookie-cutter" models will be used frequently in industries with their standards [15].

The Importance of Laboratories in Engineering Education

From the beginnings of engineering schools in the 19th century, laboratories have been staples in engineering curricula to equip engineers with the theoretical knowledge and hands-on practice necessary for the profession [1, 16]. The laboratory setting has experienced various adaptations, the greatest of which has been the integration of computers for collecting, processing, and outputting data [17]. It also allows for finite element analysis, safer alternatives to labs, and effectively visualizing abstract concepts as a supplement and near substitute to traditional laboratory settings [18-20]. Including these tools has also created the space for distance learning via synchronous video lectures and asynchronous lab activities [21, 22].

Laboratories are a critical aspect of engineering education, yet this is not always apparent when reading literature. While there are assumptions that labs are not observed critically because of their universally accepted status in the curriculum [23], it is problematic that from 1993 to 2002, only 5% of all articles published in the Journal of Engineering Education used "laboratory" as a keyword [24]. These lab courses should not, however, be overlooked because they are prime locations to achieve the goals of ABET and the American Society of Engineering Education (ASEE) to teach "21st Century Skills" such as teamwork, communication, and lifelong learning [25-28].

Industrial Collaboration in Engineering Curricula

Industrial partnership is a critical factor in engineering curricula across the globe. It has shown to be a major driver for economic development, innovation, and curriculum advisory, with many advances highlighting a universal agreement on the importance of industrial-academic collaboration [29-31]. These advances come from areas including Europe, Latin America, Central Africa, and Southeast Asia, highlighting the advances in education for engineering topics such as industrial engineering, renewable and nonrenewable energy, and engineering design [32-34]. Works include collaborating with industry to develop the curriculum of courses in graduate programs, where companies collaborated to offer professional development, co-advising, digital and physical resources, and guest lectures [35, 36].

Classroom Design

The pilot study was conducted in a senior-level mechanical engineering laboratory course that covered fluid mechanics concepts. This one-credit-hour lab meets weekly on Fridays, with a maximum class size of twenty students. One section of the course is offered each academic year in the fall semester, and the instructor for the lab is typically a graduate student, overseen by an advising faculty. The course objectives were to complete numerical (in-person) or analytical (ANSYS simulation) experiments that covered concepts such as Reynolds number, venturi meters, major and minor losses, and airfoil aerodynamics. The class would begin with a brief introduction to the lab and explain portions of the lab manual, which were posted before class for preview. The students would then be released to complete the labs independently or with the instructor's assistance for the remainder of the laboratory time. After completing the experiment or simulation, the students would write their lab reports and submit them for grading. In this course, students were not given a template to support their submission, but the rubric was posted to the course webpage at the beginning of the semester for their reference. This rubric can be seen in Appendix A.

In previous courses, students were not given post-submission revision opportunities for each lab report, as they only received feedback upon completing their lab reports, which were the only graded portions of the courses. The instructor would grade the report submissions and then distribute grades on the course webpage, including instructor comments and feedback, within a week after the students submit their reports. In the pilot study semester, educational techniques such as student-based peer review and second attempts after receiving feedback were not deployed, as this was the course's instructor's direction. In the spring semester, such educational practices will be deployed for students. A template has been used and slightly modified for the previous five academic years. The template and rubric can be seen in Appendix D and E, respectively. As an opportunity to encourage industry collaboration in the engineering curricula, along with offering stability to smaller engineering programs that need high-quality, repeatable structure, creating a consistent writing template for lab courses would allow universities to tap into the practices and wisdom of industrial professionals (of whom should include alums), and build relationships through continual education and collaboration. In this experiment, the advisory board of the engineering college was asked to provide technical writing templates from their companies for review by the authors. Research facilities on the university campus were also contacted, and Standard Operating Procedure documents were requested to supplement the pool of documents collected. These documents were analyzed, and an experimental template was developed to catch key features in the pool of documents not previously used in classes. The experimental template was then compared against the original rubrics and modified appropriately.

The experimental writing template and an updated rubric incorporating the included report material were introduced to the class in the 8th week of the semester. Students were incentivized to write in this style by incorporating these concepts into the established rubric and including them as grades for the student's assignments. The revised rubric, with highlights to indicate the changes, can be seen in Appendix B, and the experimental rubric can be seen in Appendix C. The students were graded for having the key topics discussed and the quality of the submitted technical writing. This was done using the clause "adequate details" to the sections covering the materials, methods, essential formulas, calculations, and overall report sections of the rubric, which would have a combined weight of 35% at the instructor's discretion.

The significant differences between the original rubric and the experimental template are adding a table of contents, health and safety contacts, a table of essential formulas, highlighted headings, and revision history tables. These features were seen in the industry-sponsored writing templates and research facility SOP templates. After the semester, students were asked to fill out a survey highlighting their feedback on the structure of the assignments and the clarity with which the material was presented. The survey ended with an open-ended question for feedback that the previous questions would not cover. This survey can be seen in Appendix F.

Purpose of Key Features

As stated, the experimental templates and rubric include key nuances that increase students' exposure to technical writing practices. When posted on Blackboard, these features were shown solely in the template, each being discussed at the instructor's discretion. The key features included from previous templates and rubrics are the table of contents section, health and safety, table of essential formulas, highlighted headings, and revision history tables.

1. A table of contents was included because it is a feature in the industry-provided and university-provided templates. The university-provided templates regard the graduate school's thesis and dissertation template. This is important because it exposes students to the content they need to know if they apply to graduate schools and pursue a thesis-based master's or write a dissertation.

2. In the industry, including a health and safety section in one's report or standard operating procedure allows the students to think critically in the event of an injury and establishes a point of contact for future students looking to replicate the work conducted in the lab.

3. The table of essential formulas was included in the sample calculation section to introduce the formulas for a given experiment and test the student's ability to explain

the theoretical principles before applying them in the sample calculations section. It was included for organizational sake and to assess student knowledge.

4. Highlighted headings were used in industry partner's templates to quickly section off each portion of the report, making the key topics and subtopics easier to locate. These visual cues provide formal contrast in presentation and are therefore necessary for students to apply in their writing.

5. The revision history table was found in industry partner templates. It was included because it supports the academic practice of peer review and allows students to understand the industrial practice of revision before deployment. In some educational settings, students submit their work in a closed system where edits and re-works are not allowed past their first submission, which does not replicate industrial practices. Adding a table and space to initial the revisions will enable teams to work on a report. It gives context for the engineers editing the procedures when they were edited and a description of the edits performed.

Results and Discussion

Third-party faculty collected informed consent documentation during the 8th week of class, and the experimental lab report template, along with an updated rubric, was implemented into the course during the 9th week of class for students to use for the remainder of the 15-week course. Assignments were collected, graded, and returned with instructor feedback. The class size in this section of the course was seven students.

The data was taken from the informed consent students (n = 3). The data analyzed included assignment scores before and after the new template and instructor comments on penalized sections before and after the change in the template. The lab, title, average score, and common instructor feedback per report can be seen in the table below. The asterisk in the table denotes the labs where the experimental lab template was used for report submissions. It can be seen through the reports that the more common errors made by students did not include sample calculations, lack of discussion, and a need to compare the experimental data to their analytical values. While these errors persisted after introducing the experimental template, the variance decreased, as only three consistent errors were among the data collected. The table of contents was asked to be included in the report, but doing so correctly appeared to be an issue. From this, one can reason that supplementary content should be provided to students for building the table of contents in Microsoft Word or to encourage team collaboration to diagnose these issues.

Lab #	Lab Title	Average Score	Comments
1	Fundamental properties of fluids	92.0	○ Lack of images, details, and purpose of the used materials ○ Missing discussion of data and comparison with standard data ○ Cover page formatting
2	Viscosity of fluid by falling ball viscometer	94.7	○ Missing discussion of data and comparison with standard data
3	Viscosity of fluid by Brookfield digital viscometer	92.3	○ Missing discussion ○ The formatting of sample calculations is unclear
4	Karman Vortex simulation	96.0	○ Include in-text citations for standard data, along with reference page ○ Include details involved in setting up the correct simulation conditions
5	Venturi meter simulation	93.0	○ Include Sample calculations ○ Incorrect explanation of background information ○ Missing discussion of data and comparison with standard data
6	Bernoulli's apparatus and equation application	96.3	○ More details are needed in the discussion ○ loss of third-person, past-tense writing
7	Major losses experiment	96.7	○ Incomplete sample calculations section
8*	Minor losses experiment	90.3	○ Used the wrong template ○ Lack of sample calculations ○ Issues with table of contents
9*	Laminar and Turbulent Flow	94.7	○ Lack of sample calculations ○ Issues with table of contents ○ Missing reference section
10*	Thermal Conductivity	90.7	○ Lack of sample calculations ○ Issues with table of contents ○ Experimental procedure errors ○ Missing discussion of data and comparison with standard data

Table 2, the average scores and the instructor comments that were given by lab report. The asterisk (*) denotes labs where students used the experimental lab template.

Students were also asked to complete a post-experiment survey to provide specific feedback on the experiment. The average scores are shown in the table below. The survey questions are in Appendix F. There was an 11th question asking for specific feedback, but none were given by those who filled out the survey.

Question	1	2	3	4	5	6	7	8	9	10
Average Response	9.3	8.0	7.3	8.7	8.7	9.0	6.3	7.7	8.3	6.0

Table 3, Average response scores to the student survey by question.

From this table, the students felt that the instructions and expectations were presented (questions 1 and 5, respectively), the experiment was relevant to Mechanical engineering concepts (question 6), and they felt confident in applying the skills learned from the experiment (question 4). The lowest answers were how likely they would recommend this experiment in future courses (question 10) and their feeling that the template effectively improved their technical writing skills (question 7). A reason for this could be that this experiment was conducted on a senior-level course, so the students in the course had greater exposure to scientific writing than those in freshman and sophomore-level courses. While these questions yielded the lowest survey scores, the answers still indicated a recommendation of the goals set out for the experiment.

Conclusions, Limitations, and Future Work

In the Fall 2024 pilot study, the "best-of-breeds" lab report template was implemented into a senior-level mechanical engineering laboratory course covering fluid mechanics concepts. This template was developed using writing templates from industry partners and university research facilities. The goal of the pilot study was to

1. Schedule, propose, and collect informed consent from students for the research study.
2. Successfully change the lab report template and updated rubric in the laboratory course.
3. Posting the post-lab survey after the semester as an open-ended evaluation for students.

Goals 1 and 2 were completed during the 8th week of the semester, and Goal 3 was completed during the last week of classes. Limitations in this work include the location of universities relative to potential industry partners. This study was conducted in a capital city, where the industry was diverse, and there were plenty of partnerships. These resources will be much thinner for those universities in rural locations due to the lack of diverse industry partners. The small number of students could also have an impact on the results. Because the class sizes would have less than 20 students each semester, the instructor had more individualized feedback and instruction opportunities.

Conclusions from this pilot study include that students were given clear instructions and expectations for the assignments and understood the relevance of the experiment to Mechanical engineering concepts. The errors seen in both templates could be adjusted by using proven methods such as peer review before final submission, and the template was valuable for the course's instruction.

Future work from the pilot study includes implementing educational practices such as student-based peer review before final submissions, incorporating a curriculum-wide technical writing standard, applying the industry-engaged technical writing standards at a larger university scale, and the impact on industry engagement and student employment. A more comprehensive study will also be conducted in the spring semester 2025 in the Senior-level Mechanical Engineering laboratory that covers materials testing concepts. The results of this study, in cooperation with the protocols established by the university institutional review board, are open to being shared with the industry partners who have participated, along with the industrial advisory board. Doing such would foster collaboration at meetings, create a curriculum and assignment pool influenced by the current industry standards, and allow recurring reviews to be conducted if new writing techniques are employed across the industry.

Acknowledgments

The authors would like to recognize the industrial partners on the UA Little Rock DCSTEM leadership council and Dr. Alexandru Biris from the UA Little Rock Center for Integrative Nanotechnology Sciences for their assistance in the research, which included providing technical writing and standard operating procedure templates. The authors would also like to thank Dr. Anindya Ghosh for obtaining informed consent from the study participants. Lastly, the authors would like to recognize the UA Little Rock Institutional Review Board for their guidance and clearance for the research conducted.

References

[1] L. D. Feisel and A. J. Rosa, "The role of the laboratory in undergraduate engineering education," *Journal of engineering Education,* vol. 94, no. 1, pp. 121-130, 2005.

[2] *Criteria for Accrediting Engineering Programs,* ABET, 2022.

[3] W. H. Guilford, "Teaching peer review and the process of scientific writing," *Advances in physiology education,* vol. 25, no. 3, pp. 167-175, 2001.

[4] J. Ford and S. Teare, "The right answer is communication when capstone engineering courses drive the questions," *Journal of STEM education,* vol. 7, no. 3, 2006.

[5] W. E. Britton, "What is technical writing?," *College Composition and Communication,* vol. 16, no. 2, pp. 113-116, 1965.

[6] C. Brooks and R. P. Warren, *Understanding Poetry: By Cleanth Brooks and Robert Penn WOrren*. Holt., 1960.

[7] A. F. Warsame, "The Gap Between Engineering Education and Post-graduate Preparedness," Ed.D., Walden University, United States -- Minnesota, 10634462, 2017. [Online].

[8] C. Fey, "Engineering Good Writing," (in English), *Training,* vol. 24, no. 3, p. 49, Mar 1987, 2023-09-18 1987.

[9] W. Jensen and B. Fischer, "Teaching technical writing through student peer-evaluation," *Journal of technical writing and communication,* vol. 35, no. 1, pp. 95-100, 2005.

[10] B. Daniell, R. Figliola, D. Moline, and A. Young, "Learning to write: Experiences with technical writing pedagogy within a mechanical engineering curriculum," in *2003 Annual Conference*, 2003, pp. 8.818. 1-8.818. 10.

[11] J. E. Sharp, B. M. Olds, R. L. Miller, and M. A. Dyrud, "Four effective writing strategies for engineering classes," *Journal of Engineering Education,* vol. 88, no. 1, pp. 53-57, 1999.
[12] N. Gnanapragasam, "Evolution of Technical Writing in Senior Design--A Case History," *Advances in Engineering Education,* vol. 2, no. 1, p. n1, 2010.
[13] D. Winsor, "Joining the engineering community: How do novices learn to write like engineers?," *Writing About Writing: A College Reader*, pp. 640-646, 1990.
[14] W. W. Werner, "Models and the teaching of technical writing," *Journal of technical writing and communication,* vol. 19, no. 1, pp. 69-81, 1989.
[15] M. E. Gorman, "Charles Bazerman, Shaping Written Knowledge: The Genre and Activity of the Experimental Article in Science," *Social Studies of Science,* vol. 20, no. 1, pp. 169-172, 1990.
[16] U. S. M. Academy. Administrative History.
[17] S. Hoole, "SPECIAL ISSUE ON COMPUTATION AND COMPUTERS IN ELECTRICAL-ENGINEERING EDUCATION," vol. 36, ed: IEEE-INST ELECTRICAL ELECTRONICS ENGINEERS INC 345 E 47TH ST, NEW YORK, NY …, 1993, pp. 1-1.
[18] J. Kadlowec, P. Von Lockette, E. Constans, B. Sukumaran, and D. Cleary, "Visual beams: tools for statics and solid mechanics," in *32nd Annual Frontiers in Education,* 2002, vol. 1: IEEE, pp. T4D-T4D.
[19] J. Baher, "Articulate virtual labs in thermodynamics education: A multiple case study," *Journal of Engineering Education,* vol. 88, no. 4, pp. 429-434, 1999.
[20] H. Hodge, H. S. Hinton, and M. Lightner, "Virtual circuit laboratory," *Journal of Engineering Education,* vol. 90, no. 4, pp. 507-511, 2001.
[21] N. N. Bengiamin, A. Johnson, M. Zidon, D. Moen, and D. K. Ludlow, "The Development of an Undergraduate Distance Learning Engineering Degree for Industry-A University/Industry Collaboration," *Journal of Engineering Education,* vol. 87, no. 3, pp. 277-282, 1998.
[22] D. Gillet, H. Latchman, C. Salzmann, and O. Crisalle, "Hands-on laboratory experiments in flexible and distance learning," *Journal of Engineering Education,* vol. 90, no. 2, pp. 187-191, 2001.
[23] K. D. Stephan, "All this and engineering too: a history of accreditation requirements," *IEEE technology and society magazine,* vol. 21, no. 3, pp. 8-15, 2002.
[24] P. C. Wankat, "Analysis of the first ten years of the Journal of Engineering Education," *Journal of Engineering Education,* vol. 93, no. 1, pp. 13-21, 2004.
[25] L. J. Shuman, M. Besterfield-Sacre, and J. McGourty, "The ABET "professional skills"—Can they be taught? Can they be assessed?," *Journal of engineering education,* vol. 94, no. 1, pp. 41-55, 2005.
[26] E. W. Ernst, "Workplace changes and engineering education reform," in *Technology-Based Re-Engineering Engineering Education Proceedings of Frontiers in Education FIE'96 26th Annual Conference,* 1996, vol. 2: IEEE, pp. 882-885.
[27] D. Apelian, "Re-engineering engineering education: paradigms and paradoxes," *Advanced Materials & Processes,* vol. 145, no. 6, pp. 110-115, 1994.
[28] T. Kreiwall and K. Mekemson, "Instilling the entrepreneurial mindset into engineering undergraduates," *Journal of Engineering Entreprenurship,* vol. 1, no. 1, pp. 5-19, 2010.

[29] L. Dooley and D. Kirk, "University-industry collaboration: Grafting the entrepreneurial paradigm onto academic structures," *European Journal of Innovation Management,* vol. 10, no. 3, pp. 316-332, 2007.
[30] J. Guimón, "Promoting university-industry collaboration in developing countries," *World Bank,* vol. 3, pp. 12-48, 2013.
[31] I. L. Hurtado, J. Crichigno, and A. J. Perez, "A Successful Partnership between Industry and Academia: Curriculum Improvement, Research, and Outreach through Collaboration with Industry," in *2014 ASEE Annual Conference & Exposition*, 2014, pp. 24.115. 1-24.115. 18.
[32] B. Camacho and R. Alexandre, "Design Education. University-industry collaboration, a case study," *The Design Journal,* vol. 22, no. sup1, pp. 1317-1332, 2019.
[33] G. Comodi *et al.*, "Analysis of labour market needs for engineers with enhanced knowledge in renewable energy in some European and Latin-American Countries," *Energy Procedia,* vol. 158, pp. 1135-1140, 2019.
[34] P. Koomsap, H. T. Luong, R. M. Lima, T. Nitkiewicz, W. Chattinnawat, and D. Naayutthaya, "Roles of MSIE graduates to support Thailand sustainable smart industry," *Transdisciplinary Engineering for Complex Socio-technical Systems,* pp. 75-84, 2019.
[35] M. A. Valiente Bermejo, M. Eynian, L. Malmsköld, and A. Scotti, "University–industry collaboration in curriculum design and delivery: A model and its application in manufacturing engineering courses," *Industry and Higher Education,* vol. 36, no. 5, pp. 615-622, 2022.
[36] T. Thune, "Success Factors in Higher Education–Industry Collaboration: A case study of collaboration in the engineering field," *Tertiary Education and Management,* vol. 17, pp. 31-50, 2011.

Appendix A- Fall 2024 Control Lab Report Rubric

Lab report details	Points
Cover (Title) Page (All in Times New Roman, 24 pt font)	**5**
× Title of the lab	1
× Lab Number	1
× Student name, email & Instructor name, email	1
× Course number and name	1
× Date performed (lab experiment)	0.5
× Due date (lab report)	0.5
Objective(s) and Purpose	**5**
× Brief and clear aim(s) of the lab experiment	5
Background (Introduction) - citations required	**10**
× Relevant and brief background on lab experiment topic (one or two paragraphs based on the information from your textbook or online resources). **Note**: *Add appropriate citation(s) in background. Do not plagiarize.*	10
Health and Safety	**5**
× List all necessary or advised PPE here. Includes (but not limited to): safety glasses, hearing protection, closed-toed shoes, gloves, long pants (not shorts), lab coat If this experiment is numerical (using ANSYS Fluent, ANSYS Mechanical, etc.), state it here. Also, state which PPE would need to be used if the experiment were done analytically (in the laboratory).	5
Materials and Methods	**40**
Materials:	
× Adequate details on various materials, equipment, and instruments used to perform the lab experiment	10
× Added figure(s) (*images/pictures*) on various materials used	5
Methods:	
× Details on measuring parameters (independent and dependent variables)	5
× Adequate details (one or two paragraphs) on experimental procedure used to perform the lab experiment	10
Important Formula & Sample Calculation:	
× Added detailed calculations (sample calculation) including formulas, unit conversions, calculation steps, etc.	10
Results (and Discussion)	**20**
× Data table	10
× Explained main data (results) from the data table (one or two paragraphs)	5
× Compared experimental data with the standard data (*from textbook/internet source*) and added appropriate justification if any error(s)	5
Conclusion(s)/ Summary	**5**
× Added clear conclusion(s) or summary based on the experimental results	5
References Page (and Appendix, if any)	**5**
× Added "Reference page"	5
Overall report	**5**
× Grammar: Appropriate use of "**Third person and past tense**", spelling, report format × Font type and size: **Times New Roman** and **12 font size**	5
Total Points	**100**

Appendix B- Experimental Lab Report Rubric (Changes highlighted in yellow)

Lab report details	Points
Cover (Title) Page (Centered, All in Times New Roman, 24 pt font)	**5**
× Title of the lab	1
× Lab Number	1
× Student name, email & Instructor name, email	1
× Course number and name	1
× Date performed (lab experiment)	0.5
× Due date (lab report)	0.5
Objective(s) and Purpose	**5**
× Brief and clear aim(s) of the lab experiment	5
Background (Introduction) - citations required	**10**
× Relevant and brief background on lab experiment topic (one or two paragraphs based on the information from your textbook or online resources). **Note**: *Add appropriate citation(s) in background. Do not plagiarize.*	10
Health and Safety	**5**
× List all necessary or advised PPE here. Includes (but not limited to): safety glasses, hearing protection, closed-toed shoes, gloves, long pants, lab coat If this experiment is numerical (using ANSYS Fluent, ANSYS Mechanical, etc.), state it here. No PPE is necessary	5
Materials and Methods	**30**
Materials:	
× Adequate details on various materials, equipment, and instruments used to perform the lab experiment	5
× Added figure(s) (*images/pictures*) on various materials used	5
Methods:	
× Details on measuring parameters (independent and dependent variables)	5
× Adequate details (one or two paragraphs) on experimental procedure used to perform the lab experiment	5
Important Formula & Sample Calculation:	
× Added detailed calculations (sample calculation) including formulas, unit conversions, calculation steps, etc.	10
Results (and Discussion)	**30**
× Data table	10
× Explained main data (results) from the data table (one or two paragraphs)	10
× Compared experimental data with the standard data (*from textbook/internet source*) and added appropriate justification if any error(s)	10
Conclusion(s)/ Summary	**5**
× Added clear conclusion(s) or summary based on the experimental results	5
References Page (and Appendix, if any)	**5**
× Added "Reference page"	5
Overall report	**5**
× Grammar: Appropriate use of "**Third person and past tense**", spelling, report format × Font type and size: **Times New Roman** and **12 font size**	5
Total Points	**100**

(Course Name)
(Course Number)

(Lab Number): (Name of Experiment)

Submitted by:

(Name)

(School Email)

Submitted to:

(Instructor’s Name, Instructor's Email)

Date Performed: (MM/DD/YYYY)

Due Date: (MM/DD/YYYY)

TABLE OF CONTENTS

1. INTRODUCTION

(Explain the lab/experiment in 100-200 words. Include relevant and brief backgrounds on the lab experiment topic. Give an abstract of the experiment, what it entails, and a summary of the data measured with the experiment.

2. OBJECTIVE (OF EXPERIMENT)

(The objective of the process is to measure x and y to determine the mechanical properties a, b, and c. This should also be around 100-200 words)

3. PURPOSE (OF REPORT)

The purpose of this document is to report the experiment's findings on (date), along with the processes and details necessary for sufficient repeatability (This should be around 100 words)

A. RESEARCH QUESTIONS

1. Write Post Lab Questions Here (If applicable)

4. HEALTH AND SAFETY

A. PERSONAL PROTECTIVE EQUIPMENT (PPE)

- List all necessary or advised PPE here. Includes (but not limited to): safety glasses, hearing protection, closed-toed shoes, gloves, long pants (not shorts), lab coat
- If this experiment is numerical (using ANSYS Fluent, ANSYS Mechanical, etc.), state it here.

B. EMERGENCY CONTACTS:

- University Health Services:
    - Phone:
    - Location:
- University Department of Safety:
    - Phone:

5. MATERIALS

A. APPARATUS (MACHINE OR SOFTWARE USED)

- Brand (or Software Name):
- Model Number (or edition):
- Picture of the Machine (or pictures of your ANSYS mesh):

B. TESTING MATERIAL INFORMATION

- Material List and Uses
    - Provide applicable properties to the experiment
        - Ex. Thermal Conductivity, Density, Viscosity, Young's Modulus, etc.

C. FLUIDS USED

- Lists Chemicals or Fluids used. If no fluids are used, type "No Fluids are used in this experiment."
- If used, provide pictures of the fluids
- If this is a numerical experiment, list the properties of the fluids from ANSYS (provide screenshots).

6. EXPERIMENTAL PROCEDURE

Reference the lab manual steps to complete this report portion, writing in past tense and 3rd person. Provide adequate details (one or two paragraphs) on the experimental procedure used to perform the lab experiment.

7. IMPORTANT FORMULAE & SAMPLE CALCULATIONS

Name	**Formula**

- Sample Calculations go here:
    - Include unit conversions, calculation steps, etc.

8. RESULTS

A. SPECIMEN

- Show a picture of a specimen during and after testing (if applicable)
- Show pictures of the machine while running the experiment (if applicable)
- If this is a numerical experiment, provide screenshots of the mesh after running the experiment

B. DATA COLLECTED

- Show data tables with numbers collected before/after the experiment as instructed in the lab manual
- Then show graphs/charts/plots of the data as instructed in the lab manual

C. DISCUSSION

- Explain main data (results) from the data table (one or two paragraphs)
- Compare experimental data with the standard data (from textbook/internet source) and added appropriate justification if any error(s)

9. CONCLUSIONS

Write your conclusions from the lab, answer post-lab questions, and give commentary, expectations, and future studies. Add clear conclusion(s) or summary based on the experimental results

REFERENCES

1. List References Here

REVISION HISTORY

REV #	RELEASE DATE	REVISED BY	REVISION DESCRIPTION
0	(Submission Date)	(Your Name) (School Email)	N/A
1			
2			
3			
4			

Appendix D- Spring 2023 - 2024 Lab Report Template and Spring 2025 Control Template

Course Name

(Course Number)

Lab V- Name of Lab

Semester Year

Submitted by:

Date:

1. Introduction

This experiment aims to…

2. CAD Model or Pictures of Experiment

3. ANSYS Workbench Project Schematic (if used)

4. ANSYS Mechanical Setup (if used)

5. Results

Graphs, Charts, Tables, and Pictures of Broken Specimen go here.

6. Conclusion

Answer Lab Questions and comparisons. Commentary on the Lab (what did you expect? Not expect? Any future studies with this that interest you?)

References (if needed)

Appendix E- Spring 2023-2024 Rubric and Spring 2025 Control Lab Report Rubric

Rubric Detail

	Levels of Achievement				
Criteria	**Incomplete**	**Below Average**	**Average**	**Above Average**	**Full Points**
Introduction **Weight 20.00%**	**0.00 %** No Title Page or Introduction	**50.00 %** Missing either Title Page or Introduction	**75.00 %** Some work completed, errors are evident	**90.00 %** All tasks were completed with a few minor errors or missed discussions or equations.	**100.00 %** Title Page, filled out completely. Introduction shows a clear and concise summary of the concepts, equations used, and aim of experiment
CAD Model / Set up photos **Weight 20.00%**	**0.00 %** No Pictures	**50.00 %** Very little Pictures of set up or design can be seen in the report / submission	**75.00 %** Missing Pictures but overall concept can be seen	**90.00 %** Pictures were given, but unclear, mislabeled, or missing some necessary details	**100.00 %** Necessary pictures were provided as to detail the set up for a future student to repeat this experiment.
Data/Results **Weight 20.00%**	**0.00 %** No Data or Graphs	**50.00 %** Graphs and data tables are missing, incomplete, or not reported.	**75.00 %** Data Tables and Graphs are missing figure numbers and axis labels.	**90.00 %** All Data tables are provided in but are not clear, or missing axis labels and units.	**100.00 %** All Data tables are provided in their document, filled out, along with graphs to analyze the data.
Conclusions **Weight 20.00%**	**0.00 %** No Concluding discussion or post lab questions.	**50.00 %** Very Little Conclusion, Discussion, or attempt at answering questions	**75.00 %** Some discussion and answers to post lab questions, some, however were not answered	**90.00 %** Discussion about the expectations, potential errors, conclusions, and post lab questions are attempted, with some details missing or some incorrect answers	**100.00 %** Discussion about the expectations, potential errors, conclusions, and post lab questions are clearly answered.
Submission **Weight 20.00%**	**0.00 %** No supporting files were attached.	**50.00 %** Files are Mislabeled and missing multiple files.	**75.00 %** Files are mislabeled or a file is missing.	**90.00 %** All Reports, Excel Sheets, CAD Models, Scripts, etc. are attached but some are missing name convention.	**100.00 %** All Reports, Excel Sheets, CAD Models, Scripts, etc. are labelled properly and attached in the submission.

Appendix F- Post Experiment Survey

1. How clear were the instructions for the laboratory experiment?
    a. (1 being very unclear, 10 being very clear) ________
2. To what extent did you feel prepared to conduct the experiment?
    a. (1 being very unprepared, 10 being very prepared) ________
3. Rate the usefulness of the technical writing templates provided for completing your laboratory report.
    a. (1 being not useful at all, 10 being extremely useful) ________
4. How confident are you in applying technical writing skills learned from this experiment to future assignments?
    a. (1 being not confident at all, 10 being extremely confident) ________
5. How satisfied are you with the instructor’s communication of expectations?
    a. (1 being very unsatisfied, 10 being very satisfied) ________
6. Rate the relevance of the experiment to your overall understanding of mechanical engineering concepts.
    a. (1 being not relevant at all, 10 being extremely relevant) ________
7. How effective was the incorporation of industry-standard templates in improving your technical writing skills?
    a. (1 being not effective at all, 10 being extremely effective) ________
8. To what degree did this experiment enhance your understanding of proper experimentation techniques?
    a. (1 being not enhanced at all, 10 being greatly enhanced) ________
9. Rate your overall satisfaction with the laboratory experiment.
    a. (1 being very unsatisfied, 10 being very satisfied) ________
10. How likely will you recommend incorporating similar industry collaborations into future laboratory courses?
    a. (1 being very unlikely, 10 being very likely) ________
11. Please share any additional comments or suggestions for improving future laboratory experiences.