MTSE 4090: Senior Design I
Fall 2025 Syllabus

Class Schedule & Credits

Course Dates	08/18/2025 – 12/12/2025
In-Class Sessions	Tu/Th 1:00 pm to 2:20 pm
Classroom	DP B157
Credits	3 credits

Instructor

Name	Dr. Dwight Burford (Faculty Page)
Office	DP E215g (2nd floor, in "Aloha Way" aisle)
Office Hours	By appointment via email (face-to-face or via Zoom/Teams)
Email	dwight.burford@unt.edu

Note: Depending on the scope and complexity of the communication, most emails are expected to be answered within 24 to 48 hours.

Contact Hours

- Class time is to be split between instruction and independent teamwork.
  - Classroom instruction: Either on a Tuesday or Thursday as announced.
  - Independent teamwork: On the opposite day each week of the lecture.

Textbook

- No specific text is required for this course.
- Supplemental materials will be provided throughout the semester via Canvas or MS Teams.
- Additional references may also be given on lecture slides and in handouts.

Submissions

- As assigned in Canvas.
- All project files will be submitted in an assigned Microsoft Teams channel.

Teams and Team Projects

- Students will work in teams of three or four students.
- Each team will work on a project identified in the Fall semester from a list of available projects.
- Each team will continue working on the same project in the spring in MTSE 4100.
- All project files will be maintained and submitted in an assigned Microsoft Teams channel.
- Each team is to carry out their project planning and execution in an organized and professional manner.

Grading

- Students will be evaluated based on **individual and team participation** through submitted progress reports, team evaluations, prepared presentations, posters, and written reports. Key elements include:
    - Teamwork (maintaining a professional working relationship within the team)
    - Regular meetings with the project advisor(s) and sponsor(s)
    - Weekly class attendance (one day a week)
    - Timely submission of reports and presentations
    - Demonstrating progress on developing and implementing project tasks
    - Presentation, poster, and defense
    - Final Written Report
- Grades will be assigned each team using the following scale but may be adjusted for individual performance and teamwork:

A: 90-100 | B: 80-89.99 | C: 70–79.99 | D: 60–69.99 | F: 0–59.99

Course Schedule

General weekly topics: Weekly theme topics and content may change or be updated throughout the semester.

Week 1: Introduction / orientation / proper attribution of artificial intelligence (AI)
Week 2: Introduction to ABET criterion goals / ethics / project assignments / safety / liability
Week 3: Project management / gathering technical information (including patents and standards) / etc.
Week 4: ABET criterion 3, #2 / engineering design process / standards / constraints / the environment / continuous quality improvement (CQI) / etc.
Week 5: ABET criterion 3, #3 / schedule review / project definition update / Q & A
Week 6: **Project Definition Report & Presentation DUE** – Report & 5 min presentation to advisory groups, questions and answers (rubric to be provided)
Week 7: Week 6 review / jargon / ABET criterion 3, #5 / environmental aspects of design
Week 8: ABET criterion 3 general requirements / engineering standards / sustainable development / form, fit, and function
Week 9: Team meetings with course instructor / prepare and present progress report to advisors for their review in preparation of Week 10 presentation and submission of mid-semester report
Week 10: **Background Report and Presentations DUE –** Report & 5 min presentation to advisory groups, questions and answers
Week 11: Gen Z HR article / batteries and computers (including recycling) / AI expansion
Week 12: Global engineering context and challenges / examples / teams to present progress report to advisors
Week 13: Discussion Topic: Tires, Entrepreneurs, and the Environment / progress meeting with advisory groups—present draft Poster & Defense to advisors
Week 14: **Presentation and Defense**
Week 15: **Final Written Report & Team Evaluations DUE**

Artificial Intelligence (AI) General Policy

- AI may be used in developing and preparing the formulation of team projects during the course under certain conditions outlined in this section.
- **Proper attribution of AI must be clearly included in reports and presentations**.
- That is, information and data acquired through open AI chatbots (programs), such as ChatGPT, Grok, Gemini, etc., must be cited and/or referenced clearly in all presentations and reports.
- In reports, the following requirements must be met:
  - First, include the question and/or information input to prompt the AI chatbot.
  - Second, clearly quote the relevant output from the chatbot or similar program.
- While AI is used in most word processing programs, e.g. MS Word, you may not use AI chatbots to generate your reports.
  - All material from a chatbot must be clearly identified as referenced material, not represented as your own work.
  - Any report content that is AI generated that is not properly attributed (referenced) will be treated as plagiarism.

Additional Course Details

a. Brief description of the content of the course (catalog description).

- The primary objective of this course is to provide every student with "real world" engineering design teaming experience that draws on the knowledge/skills that have been mastered during their studies in the Department of Materials Science and Engineering at the University of North Texas.
- **Students shall exhibit an ability to design a system, component, or process to meet a desired need**. This is a two-semester sequence with the first semester (this course, MTSE 4090), providing the preliminary work required to complete a design project in the second semester (MTSE 4100). This semester teams will determine:

  - Project scope
  - Technical background by a literature review
  - Project planning
  - Safety considerations
  - Environmental impact and ethics in design
  - Preliminary design concepts
  - Presentation of design work, both orally and in writing

b. ABET requirement: "*Prerequisites or co-requisites*"

- MTSE 3010, 3020, 3030, 3040, 3050, 3070, & 3080

c. Indicate whether a required, elective, or selected elective course in the program

- ABET requirement: "*Required*"

Specific Goals for the Course

a. ABET requirement: "*Specific outcomes of instruction*"

- Students will work in teams of three or four on selected projects with faculty mentors and are expected to function in an environment that is similar to that which they will encounter in their careers outside the university setting. As such, faculty mentors have two main functions: to serve as advisors to the senior design student/teams and as evaluators of student/team progress.
- Students are expected to operate effectively as individuals and in a team environment. Students must demonstrate the ability to establish goals, plan tasks, and meet objectives. Team evaluations will be compiled at the end of the semester using the attached rubric.
- Students will identify and describe a design problem with the help of the faculty mentor, and they must demonstrate an ability to apply basic math, science, and principles of engineering to integrate knowledge of material structure, properties, processing, and performance to solve a complex materials selection and design problem. The solutions must meet specific needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- Students must consider additional aspects such as the ethical and political impacts of the effort.
- Students will demonstrate an ability to perform a literature review in order to become familiar with the current state of the subject and an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
- Each student will demonstrate the ability to present technical information clearly in both oral and written formats by demonstrating effective communication with a range of audiences.
- Students must demonstrate ethical principles in an engineering context.

b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

- All Criterion 3 outcomes will be identified and discussed in the course
- This course specifically addresses ABET Student Outcome(s): 1, 2, 3, and 4

Team Responsibilities

- Teams are responsible for:
  - Planning and coordinating meetings outside of the classroom that are required for completing the project.
  - Scheduling time with the faculty advisor and industrial sponsor (if one is identified).
  - Reviewing the educational objectives carefully to determine additional details that should be considered in all senior design presentations and written reports.

- Student Design Teams are responsible for a series of written reports that build on the previous one in completing the final reports that will be submitted at the end of each semester.

- ✓ **First**, the Project Definition Report/Presentation should focus on the Goals and Objectives of the project including the problem definition, scope of work, major challenges, and general plan to complete the project. This should be detailed in the written report and outlined in a PowerPoint presentation to the faculty **in week 6.**

- ✓ **Second**, the Background Report should start with a revised Goals and Objectives and include a thorough "state of the art" literature and background search of all pertinent sources (journals, proceedings, handbooks, patents, internet, industrial literature, industrial visits, existing data, internal documents, etc.). The background literature and information should be evaluated in light of your project to provide the overall direction and ideas for the project. This report will also include the preliminary work performed as well as plans for work to be completed before the end of the semester. A detailed written report and MS PowerPoint presentation is due **in week 10.**

- ✓ **Third**, a Final Report should be built on the first reports and revisions suggested by the faculty group. The final written report along with your presentation is due at the end of the semester **in week 15**. The final written report describes in detail the following aspects of the project:

    - Goals and Objectives—based on the "Problem Definition and Scope" determined earlier with your faculty mentor.
    - Background Information—including that information developed, revised, and updated for the October "State-of-the-Art' literature review.
    - Clearly identified processing-structure-properties-performance relationships.
    - Clearly identified standards and constraints.
    - The engineering approach planned to meet the goals and objectives.
    - A discussion of the preliminary work done this semester.
    - A detailed plan for work to be accomplished next semester, including:
        - Specific tasks and anticipated timelines, including milestones—**use of a Gantt chart is required!**
        - Anticipated budgets.

- A separate document will be provided with a description of the information to be included in reports. However, every written report should include a cover page with the title of the project, the names of the design team members, the faculty advisor, industrial sponsor/contact person (as applicable, the date, course number and year, etc. The Student Design Teams also will be responsible for a 3ft x 4ft poster that *summarizes* the written report and that includes the same project aspects that are described above. Note: contact Lisa Dunlop (MSE Office) for information about printing posters etc., as needed.

- Student behavior that interferes with an instructor's ability to conduct a class or other students' opportunity to learn is unacceptable and disruptive and will not be tolerated in any instructional forum at UNT. Students engaging in unacceptable behavior will be directed to leave the classroom, and the instructor may refer the student to the Dean of Students to consider whether the student's conduct violated the Code of Student Conduct. The University's expectations for student conduct apply to all instructional forums, including University and electronic classroom, labs, discussion groups, field trips, etc. Visit UNT's

Code of Student Conduct (https://deanofstudents.unt.edu/conduct) to learn more.

Rubric

Report grades will be based on both writing and technical quality. The following rubric will be used as part of the evaluation of the Literature Review section of the Background Report for your project. Student teams will be notified if this rubric is updated during the semester.

	Unsatisfactory 1	**Developing 2**	**Satisfactory 3**	**Outstanding 4**	**Score**
Standards, Specifications, References, Material safety data sheets (MSDS)	Identified no standards or reference data	Identified one or two standards or reference data examples, of limited value	Identified one or two standards or reference data examples appropriate for project	Identified more than two standards or reference data examples appropriate for project	
Link to basic materials science	No link	A tortuous link	A clear weak link	A strong clear link	
Technical Literature Review- Journals **Is the design based on "known-knowns" and material learned in earlier coursework?**	Technical references are of little value to the project	Some useful technical references identified, but incomplete	Most technical references are relevant	Technical references are appropriate	
Overall Relevance of Literature Review Document	Not connected to desired project goal; mostly irrelevant information	Some useful information, but connection to project goal is unclear	Most information is relevant to a well-described project goal	Information is clearly relevant to a well-described project goal	
Overall Quality of Literature Review Document	Poorly written, poorly laid-out; limited or no figures; improper citations	Some problems with grammar, some sections written unclearly; figures not well-described;	Well-written, with reasonable clarity, useful figures, good use of citations; room for improvement	Very well-written with appropriate figures to supplement text and well-organized citations	

		problems with citations			
				Total Score	

Comments/Notes:

Terms and Definitions

A. **Educational Objectives:** The educational objectives for this two-semester course include elements of the following ABET Criterion 3 outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

B. <u>Engineering Teams:</u> (for a reference see, https://zeet.co/blog/engineering-team)

a. They are structured groups that collaborate to design, develop, and maintain products or systems, and their effectiveness relies on clear roles, communication, and alignment with organizational goals.
b. Key Considerations for Building Engineering Teams
    i. <u>Define Goals and Scope</u>: Before assembling an engineering team, it is crucial to clearly define the project's goals and scope. This involves identifying the problem to be solved and the desired outcomes, which helps in determining the required skill sets and roles within the team.
    ii. <u>Identify Core Competencies</u>: Understanding the technical expertise and domain knowledge needed for the project is essential. Each team member should bring a unique skill set that complements the overall capabilities of the team.
    iii. <u>Foster Collaboration and Communication</u>: Effective collaboration is vital for success. Creating an environment that encourages open communication and knowledge sharing can enhance teamwork. Regular meetings and

collaboration tools can facilitate this.

iv. Consider Team Structure: There are various structures for engineering teams, including:
    1. Horizontal Structure: Members have defined roles without a hierarchy, promoting equality and collaboration.
    2. Vertical Structure: This involves a hierarchy with increasing levels of leadership, often used for product-oriented goals.
    3. Functional Teams: Engineers are grouped by specialization (e.g., frontend, backend), ideal for organizations requiring deep technical consistency.
v. Establish Clear Roles and Responsibilities: Clearly defined roles help team members understand their contributions and work effectively towards common goals. Encouraging cross-functional collaboration can enhance ownership and accountability.

c. Best Practices for Effective Engineering Teams
    i. Strong Leadership: Effective engineering teams are often led by individuals who can provide resources, remove blockers, and foster autonomy and trust among team members.
    ii. Continuous Improvement: Teams should focus on operational efficiency and make informed technical decisions while continuously improving their processes.
    iii. Psychological Safety: Creating an environment where team members feel safe to share ideas and admit mistakes is crucial for team effectiveness.
d. Conclusion
    i. Building and managing effective engineering teams requires careful consideration of team structure, roles, and collaboration practices.
    ii. By focusing on these elements, organizations can enhance their engineering teams' performance and align their efforts with business objectives.

C. Complex Engineering Problems:

Complex engineering problems include one or more of the following characteristics:

- wide-ranging or conflicting technical issues having no obvious solution(s)
- problems not encompassed by current standards or codes
- diverse groups of stakeholders
- many component parts or sub-elements
- multiple disciplines
- significant consequences in a range of contexts

D. Engineering Design:

Engineering design is a process of devising a system, component, or process to meet desired needs and specifications within constraints. It is an iterative, creative, decision-making process in which the basic sciences, mathematics, and engineering sciences are applied to convert resources into solutions. Engineering design involves identifying opportunities, developing requirements, performing analysis and synthesis, generating multiple solutions, evaluating solutions against requirements, considering risks, and making tradeoffs, for the

purpose of obtaining a high-quality solution under the given circumstances.

E. Engineering Science:

Engineering sciences are based on mathematics and basic sciences but carry knowledge further toward creative application needed to solve engineering problems. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other.