1. The Technical Writing Process ................................................................. 2
    The prewriting process: where to start.................................................... 2
    Developing your writing process: writing and rewriting your technical documents ................................................................. 2

2. The Technical Writing Content .............................................................. 4
    Developing your evidence-based content................................................ 4
    Applying the evidence-based approach throughout your document .......... 6

3. The Style and Structure of Technical Writing ......................................... 7
    Developing your technical style.............................................................. 7
    Language: Word choice in technical writing .......................................... 8
    Structure and organization: sentences in technical writing...................... 11
    Structure and organization: Paragraphs in technical writing................... 15
    Structure and organization: Overall sections and subsections in technical reports ....................................................................................... 16
    Structure and organization: Overall sections and subsections in research papers ....................................................................................... 17

4. The Form of Technical Writing ................................................................. 18
    Developing your technical form.............................................................. 18
    Formatting................................................................................................. 18
    Using Graphics in technical documents................................................... 19
    Mastering textual mechanics.................................................................... 22

5. Concluding Remarks .................................................................................. 26

6. Bibliography ............................................................................................. 26
This document presents the MSFEA guidelines for writing technical documents. These guidelines were developed to address the weaknesses in student writing as identified by MSFEA faculty surveys and interviews. Specifically, the guidelines address means to enhance the technical writing process, content, style and structure, and form. MSFEA students are encouraged to follow these guidelines in order to improve their writing throughout their coursework and professional experiences at MSFEA and beyond.

1. The Technical Writing Process

The prewriting process: where to start

Every writing instance is unique in terms of: (1) the specific subject matter that it addresses, and (2) its writing constraints (the audience, purpose and occasion). The extent to which you will be able to control those factors will vary depending on the writing situation. For instance, while some courses will give you very specific writing prompts to respond to, other courses will give you full control over the subject that you choose to write about. Usually, however, you will have very limited control over the constraints of writing, such as who will your text address (your audience, their prior knowledge, and their prior attitudes on the subject matter), the purpose of writing (to inform, persuade, etc.), and the occasion (context) of writing (the formality of the situation, relevant ethical, political, and economic contexts, expected deadlines, etc.).

Prewriting stages involve analyzing the above constraints and fully understanding what you are expected to deliver in your writing assignments. Spend some time reading and understanding the prompts, identifying the various elements that you cannot control, brainstorming ideas about how you will address the assignment, and thinking of ways by which you can display your creativity and critical thinking abilities. The thought process that goes into this prewriting stage will help you start the writing process with more efficiency and determination.

Developing your writing process: writing and rewriting your technical documents

As MSFEA students, you will be required to write a number of technical documents, such as lab reports, class projects, internship reports, and FYP reports. Although the topics and general format of those documents may vary from one course to another, the overall process by which you are expected to write such documents is very similar.
University students often confuse writing to mean the act of typing (or penning) text in response to a certain prompt. At MSFEA, we want you to rather think about writing as a process that extends beyond a single sitting in which you write down your text. The best written technical documents are those that are well-thought and that develop over several stages and iterations.

The purpose and tasks of the different stages of technical writing are summarized in Box 1. Early writing stages involve constructing your messages through researching various sources, organizing your ideas, and building your evidence-based arguments. The outcome of this stage should be a strong draft in which you have: (1) a clear direction for what you want to achieve in your text (your scope, research question(s), and purpose statement(s)), (2) the relevant messages that you want to communicate in your document (problem statements, general findings, evaluations of those findings, etc.), and (3) the evidence needed to support your main messages (the basis on which you have developed your messages and conclusions should be clear to your readers).

Later stages of writing (rewriting) involve deconstructing your messages for your audience (who will read the document). In other words, those stages should focus on re-organizing messages and ideas in a way that frames what is important for your readers. Those later stages involve revising (re-thinking the organization and content of your sections), editing (making paragraph- and sentence-level corrections), and proofreading (making final grammatical, punctuation, and formatting corrections). The outcome of this stage should be a strategic and polished document that appeals to your target audience and responds to the writing occasion and purpose.

Box 1: The writing process involves writing and rewriting.

I. Early stages (message construction) include writing tasks such as:
   1. Researching
   2. Organizing information
   3. Building strong and evidence-based arguments

   Outcome: A strong draft with a clear direction regarding what you want to achieve in your text and the evidence-based messages that will help you achieve that goal.

II. Later stages (message deconstruction for the readers) include rewriting tasks such as:
   1. Revising (re-thinking the organization and content of your sections),
   2. Editing (making paragraph and sentence-level corrections), and
   3. Proofreading (making final grammatical, punctuation, and formatting corrections).

   Outcome: A strategic and polished document that appeals to your target audience and responds to the writing occasion and purpose.
You should give yourself the needed time and space to complete any kind of writing tasks. Do not expect to write well-thought and refined documents in single sessions. Each one of the above stages and tasks may require several iterations depending on the level of complexity of the subject matter, your knowledge and expertise, and your instructors’ expectations. With each iteration, your document will be enhanced in terms of: content (your actual messages), style (message presentation), and form (the appearance of your text). The below sections will further explain the expectations relevant to those elements of writing at MSFEA along with some pointers to help you meet those expectations.

2. The Technical Writing Content

Developing your evidence-based content

The content of technical documents refers to the information that writers synthesize and communicate to their readers. Knowing and understanding the messages that you need to communicate about should be established in the early stages of writing (see Box 1). Additionally, such messages should follow a clear and evidence-based logic. In other words, the basis on which you develop your messages and assertions should be made explicit throughout your document (see Box 2).

Box 2: Evidence-based content enhances the credibility of your text.

Consider the following statement: “We observed that the slope is unstable.”

In this example, the writers do not clarify the rationale for their assertion, which may lead readers to question the message (what did you actually observe, how does that observation relate to slope instability, etc.).

Now consider the following revised sentence: “We observed arc-shaped pavement cracks, which is typical of embankment slope instability.”

This latter sentence is an example of an evidence-based assertion where the writer offers a clear message along with the evidence leading to it.

Developing your content as such is extremely important for your readers to perceive your writing as well-supported and credible. This is especially important because it reflects positively on your credibility and professionalism as an engineer.

This approach of writing evidence-based messages can be further examined through the Toulmin Model of Argumentation (Box 3). This model provides the general structure of well-supported arguments and is widely applied in various disciplines. Based on this model, you need to start your arguments with a claim, which is an assertion/ statement/ message that you articulate and that you want to prove. Then, you begin to accumulate the evidence needed to support your claim. Such evidence may come from various sources (as long as you cite specialized information that you do not produce). After collecting the necessary
evidence, you then need to provide a warrant that links the claim to its supporting evidence. In other words, the way that the evidence may prove (or support) a claim should be made explicit to the readers. In more complex arguments that involve counterarguments, the model necessitates including rebuttal statements that disprove the counterarguments. Furthermore, in some cases, warrants themselves may need to be supported with backing statements. Box 3 includes an example to illustrate the elements of this model.

**Box 3: Use the Toulmin Model of Argumentation to build strong arguments that appeal to your audience (readers).**

**Example Claim:** Driving hybrid cars is an effective strategy to fight pollution.

**Support 1:** Driving a private car is a typical citizen's most air polluting activity.  
**Warrant 1:** Because cars are the largest source of private, as opposed to industry produced, air pollution (backing), switching to hybrid cars should have an impact on fighting pollution.

**Support 2:** Each vehicle produced is going to stay on the road for roughly 12 to 15 years.  
**Warrant 2:** Cars generally have a long lifespan (backing), meaning that a decision to switch to a hybrid car will make a long-term impact on pollution.

**Counterclaim:** Some might argue that instead of focusing on cars, which still encourages a culture of driving even if it cuts down on pollution, the nation should focus on building and encouraging use of mass transit systems.

**Rebuttal:** While mass transit is an environmentally sound idea that should be encouraged, it is not feasible in many rural and suburban areas, or for people who must commute to work. Thus, hybrid cars are a better solution for much of the nation's population.
Applying the evidence-based approach throughout your document

As discussed above, this evidence-based writing approach is extremely important for your credibility, not only as a writer, but also as an engineer. The way that you approach problems as engineers stems from researching situations and making sure that you are making accurate conclusions and calculated decisions. The same approach should be reflected in your writing. Such approach can help you build strong arguments and messages throughout your text. In this section, you will learn how this approach can be applied in writing about research information.

As engineers, you will conduct two types of research efforts: primary research and secondary research. **Primary research** refers to the original research efforts that you conduct as engineers (e.g. field observations and experiments, lab experiments, modeling and simulations, etc.). On the other hand, **secondary research** refers to seeking research information from existing credible sources (databases, scholarly papers, public and governmental records, etc.). Whether your technical writing assignment involves primary research, secondary research, or both, use this evidence-based writing approach to organize and synthesize research information.

For instance, when reporting original results:
1. Articulate each main finding in the form of an assertion using full sentences.
2. Support your assertions (main findings) with data (e.g. highlight trends, emphasize specific data points, etc.).
3. Link your main findings to the evidence provided and discuss the implications/ limitations/ interpretations, especially in relation to your overall purpose, and your readers’ interests, questions, goals, or concerns.

Similarly, when reporting information obtained from secondary sources (e.g. in the introduction/ literature review sections of your reports):
1. Articulate claims that summarize the main themes found in secondary sources about your topic of interest
2. Support those assertions (main themes) through summarizing and citing results from specific studies.
3. Link the general themes and gaps in secondary research findings to your overall purpose, and your readers’ interests, questions, goals, or concerns.
4. Finally, cite the sources used according to a uniform style that is accepted in your discipline (e.g. ASCE, ACS, IEEE, APA, etc.).

Remember that your job as an engineer is to not only produce data, but to also break down, simplify, synthesize, and analyze results for your audience (instructors, collaborators, clients, etc.). This evidence-based approach will help you achieve this goal throughout your curriculum at MSFEA and in your future career as engineers.
After developing your content, read your text critically and revise messages that are not well-supported. Your goal at this stage should be to have a strong draft content-wise. In other words, make sure that the content produced at this point has a clear (1) direction, in terms of the scope, research question(s), and purpose statement(s), (2) message, in terms of problem/gap statements, general findings, and evaluations of findings, and (3) support for the messages included, which is in turn linked to your overall purpose and to your readers’ concerns and questions.

Once you feel confident about the technical content in your draft, start focusing on the way that you are communicating and presenting your content to your readers (see Box 1). This is where you should start focusing on how to enhance your writing Style and Form in a way that improves the readability and understandability of your text. You will thus need to rewrite your draft through multiple rounds of revising, editing, and proofreading. The sections below include some important techniques to strategically communicate and present your messages to your readers through focusing on style and form.

3. The Style and Structure of Technical Writing

Developing your technical style

Style pertains to the way that you choose to present your messages. This includes language (word choice) as well as sentence and paragraph structure (overall written structure/organization, depth, and transitions). Your goal while revising your document is to rewrite your content with a style that appeals to your readers. Remember that technical writing uses a style that is different from other genres of writing that you may have used in other classes/settings. The below sections include some thorough guidelines relating to the language, structure, and illustrations used in technical writing.
## Language: Word choice in technical writing

<table>
<thead>
<tr>
<th>You are expected to use <strong>words</strong> that are:</th>
<th><strong>This means they need to:</strong></th>
<th><strong>Examples</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clear</strong></td>
<td><strong>Lack ambiguity</strong></td>
<td>Consider the following sentences:</td>
</tr>
<tr>
<td></td>
<td>The lab manager had to lower the temperature <strong>as</strong> the experiment was progressing.</td>
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<tr>
<td></td>
<td><em>(In this example, “as” is used to mean “because,” but it can be easily mistaken to mean “while.” Replacing “as” with “because” eliminates ambiguity.)</em></td>
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<td></td>
<td>Because the linear actuator controlled the opening and closing of the valve, it was designed based on DIN 3358.</td>
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<tr>
<td></td>
<td><em>(In this example, “it” refers to the “valve,” but it can be easily mistaken to refer to the “actuator.” Replacing “it” with “the latter” or simply “which was designed…” eliminates ambiguity.)</em></td>
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<td></td>
<td><strong>Be defined</strong></td>
<td>To avoid confusion about what technical terms mean, define such terms according to the following formula:</td>
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<td></td>
<td>Technical term + category + explanation.</td>
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<tr>
<td></td>
<td>Tensile strength is the capacity of a material or structure to withstand loads tending to elongate it.</td>
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<tr>
<td></td>
<td><strong>Lack complexity</strong> (jargon-free)</td>
<td>Compare the following explanations of Shear Strength tests:</td>
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<tr>
<td></td>
<td>Shear strength is the capacity of a material to withstand loads that tend to produce a sliding failure along a plane on a material. Ductile materials are preferred because they are able to withstand significant deformation.</td>
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<tr>
<td></td>
<td><em>(Some aspects of this explanation are complex, such as “produce a sliding failure along a plane on a material.”)</em></td>
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<tr>
<td></td>
<td>Shear strength tests determine the failure type –either brittle or ductile – of the specimen tested. While ductile failures occur slowly and lead to significant deformation in the specimen, brittle failures occur abruptly with little to no deformation in the material. Ductile specimen can thus be twisted before fractures (failure) occur. Additionally, the fracture plane (i.e. where the specimen breaks) occurs where the torsion/twisting stress is applied.</td>
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<td></td>
<td><em>(This is a more efficient explanation of the tests. Notice how the occurrence of complex words (jargon) is minimized and whenever technical words are used, they are explained using simple terms.)</em></td>
<td></td>
</tr>
<tr>
<td>You are expected to use words that are:</td>
<td>This means they need to:</td>
<td>Examples</td>
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<td>----------------------------------------</td>
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<tr>
<td><strong>Precise</strong></td>
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<tr>
<td>Mean exactly what is intended by the author</td>
<td>Consider the following sentences:</td>
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<tr>
<td></td>
<td>Please send a very detailed report. After recognizing some problems with the code, we took subsequent measures.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(&quot;Very detailed,&quot; &quot;some problems,&quot; and &quot;subsequent measures&quot; are not precise terms and may be interpreted differently by different readers.)</td>
<td></td>
</tr>
<tr>
<td>Avoid inaccurate and flowery language</td>
<td>Ambient lightening of the tunnel will remove the oppressive feeling that drivers had experienced with the earlier design.</td>
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<tr>
<td></td>
<td>(In this case, the metaphor is used to mean &quot;dark.&quot; However, this meaning may not be understood by all readers.)</td>
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<tr>
<td>Be as specific as needed, not more</td>
<td>The sample included 63,940,334,323 molecules of CO₂.</td>
<td></td>
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<tr>
<td></td>
<td>(Too much specificity can overwhelm readers. For instance, &quot;the sample included about 64 trillion molecules of CO₂&quot; can be more easily understood.)</td>
<td></td>
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<tr>
<td>Take into account word denotations (dictionary meaning) and connotations (meaning in context)</td>
<td>Consider the following sentences:</td>
<td></td>
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<tr>
<td></td>
<td>The design uses cheap material. The design uses inexpensive material. The design uses cost-effective material.</td>
<td></td>
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<tr>
<td></td>
<td>(Although &quot;cheap,&quot; &quot;inexpensive,&quot; and &quot;cost-effective&quot; mean &quot;low in price,&quot; each word has a different implication. &quot;Cheap&quot; may be understood to mean that something is not only low in price, but that also its quality is low. &quot;Inexpensive&quot; has a more neutral meaning in that it does not imply that the quality is good or bad. &quot;Cost-effective&quot; implies that the quality is very high relative to the cost.)</td>
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<tr>
<td>Avoid absolute terms</td>
<td>Consider the following sentences:</td>
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<tr>
<td></td>
<td>This landfill will ensure the intake of all wastes produced by the city over the next 50 years.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>This landfill will accommodate the estimated wastes to be produced by the city over the next 50 years.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Absolute terms, such as &quot;always,&quot; &quot;never,&quot; and &quot;guarantee,&quot; rarely indicate the right level of uncertainty. In the first example above, &quot;ensure&quot; indicates full certainty that the landfill will accommodate all wastes produced in the next 50 years. The second example, on the other hand, explains that the landfill will work based on the expected wastes that are estimated by the designers, which is a more precise statement.)</td>
<td></td>
</tr>
</tbody>
</table>
You are expected to use **words** that are:

**This means they need to:**

<table>
<thead>
<tr>
<th>Concise</th>
<th>Formal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid unnecessarily long words</td>
<td>Avoid informal and unprofessional language</td>
</tr>
</tbody>
</table>

Consider the following words:

- familiarization, has the functionality, has the operationability, firstly, secondly, etc.

*(Such words are unnecessarily long and complex. Because technical writing includes complex technical terminology, make sure the rest of the words used are concise.)*

Technical writing should not include:

- Contractions (won’t, can’t, shouldn’t, etc.)
- Phrasal verbs (come up with, got over, mixed up, wrap up)
- Slang and clichés (a lot of, piece of cake, bucks)
- First person pronouns (especially “I”)

*(The above list includes examples of informal language. Such language gives your text an unprofessional tone.)*
# Structure and organization: sentences in technical writing

<table>
<thead>
<tr>
<th>You are expected to write sentences that are:</th>
<th>This means they need to:</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Clear                                         | Avoid needlessly complex phrases | We used a 150mbps wireless nano WPS-compatible power saving USB adapter.  

(Long chains of adjectives and noun modifiers added before nouns can unnecessarily complicate your documents. Instead, add such defining adjectives and noun modifiers after the noun and/or split them over multiple linked sentences.) |
| Concise                                       | Avoid longwinded sentences with needless adjectives, adverbs, and verb phrases | The successful implementation of our design by the construction team relies very heavily on a rather thorough understanding of the somewhat complex nuances of our progressive approach.  

(Details are not always informative. Avoid descriptions that do not add meaning to your sentences. Removing the underlined words in this example will still deliver the same meaning. Long-winded sentences usually include unnecessary words that can be easily removed.) |
| Familiar                                      | Avoid empty and unnecessary expressions | Consider the following expressions:  

- at this point in time (now)  
- has the ability to (can)  
- in the event that (if)  
- in the vicinity of (near)  
- owing to the fact that (because)  
- there is no doubt but that (No doubt)  
- it is my intent to show that (Results show…)  

(Prepositional phrases and phrasal verbs lead to long and convoluted sentences. Usually, such expressions can be replaced by single words, or can be completely removed without affecting the meaning.) |
|                                               | Start with what is known and add new content towards the end of the sentence | The design team considered three alternatives for the cell tower location and evaluated them based on five design criteria. The alternatives were:  

1) The east slope of the hill  
2) The west slope of the hill  
3) The peak of the hill  

Based on the evaluation of the design criteria, alternative 1 fulfills….  

(In technical writing, sentences usually start with known information that was introduced earlier in the text. This helps contextualize the new information and helps readers process information faster.) |
<table>
<thead>
<tr>
<th><strong>You are expected to write sentences that are:</strong></th>
<th><strong>This means they need to:</strong></th>
<th><strong>Examples</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Include short subjects that are close to their verbs (do not separate subjects and verbs with details)</td>
<td>The ability of the freeway to accommodate nature- and human-induced wear and tear given the longevity and effectiveness of the material used is one of the considerations that the City will discuss prior to approving the project.</td>
<td><em>(The verb “are” in the above sentence occurs too far from its subject: “the ability of the freeway.” This impedes understanding the content. In this case, flipping the sentence will allow for a shorted subject: Prior to approving the project, the City will consider the ability of the freeway to ….</em>)*</td>
</tr>
<tr>
<td>List items at the end (rather than at the beginning or middle) of the sentence.</td>
<td>Consider the following sentences: Understanding the collection of programs that deliver the machine learning functionality, managing the machine learning risk, and ensuring machine learning compliance were influential in assessing the effectiveness of machine learning initiatives. Several factors were influential in assessing the effectiveness of machine learning initiatives, such as: understanding the collection of programs that deliver the machine learning functionality, managing the machine learning risk, and ensuring machine learning compliance.</td>
<td><em>(The first sentence starts with listing items. As a result, the main idea of the sentence is not understood until the very end. To avoid crowding your sentences and confusing your readers, start your sentences with the main idea, and list items at the end.)</em></td>
</tr>
<tr>
<td>Eliminate the needlessly passive voice* and use the active voice to establish responsibility.</td>
<td>Consider the following sentences: For testing static stability, it was determined appropriate by the research team to initiate and release perturbations in the structures. In order to test the static stability, the research team decided to initiate and release perturbations in the structures.</td>
<td><em>(Generally, the active voice is more direct and straightforward. Notice in the above examples how the active voice allows the writer to: use a stronger verb [decided vs. was determined] and to express the main idea more effectively and concisely. This structure is easier for readers to follow and understand.)</em></td>
</tr>
</tbody>
</table>

*Generally, passive voice is less direct and less clear. Using the active voice makes your sentences more direct and understandable.*
* Using the proper voice in technical writing:

There are several misconceptions regarding the use of the passive voice in technical writing. Many students assume that technical and professional writing is mostly passive. In reality, however, the choice to use either the passive or the active voice has to be strategic. In other words, writers should structure sentences based on the meaning that they intend to communicate.

Remember, the subject of the sentence determines whether that sentence is active or passive:

<table>
<thead>
<tr>
<th>Active voice</th>
<th>Passive voice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FCB Engineering</strong> completed the site’s environmental assessment.</td>
<td><strong>The site’s environmental assessment</strong> was completed by FCB Engineering.</td>
</tr>
<tr>
<td><strong>The subject is the entity performing the action.</strong></td>
<td><strong>The subject is the entity receiving the action.</strong></td>
</tr>
</tbody>
</table>

By structuring your sentence in the active voice, you are emphasizing the performer, or the agent, of the action (in the above example, FCB Engineering). This emphasis is especially important in situations where you want to establish responsibility for engineering-related actions (such as observations, decisions, recommendations, etc.). In those cases, your readers need to identify the agent responsible for the actions because it will help them assess the credibility and salience of the information communicated.

By structuring your sentence in the passive voice, you are emphasizing the object, or the recipient, of the action (in the above example, the site’s environmental assessment). This emphasis is especially important in situations where the performer of the action is either unknown or unimportant, or when you have already established who the agent is and the object of the action is the main topic of interest. This is why the methods sections in technical papers mostly use the passive voice. In this section, the readers already know who performed the procedures (the engineers, the technicians, etc.), and they are more interested in learning about the procedures themselves. (For example, it is repetitive and wordy to write: The research team drilled the borings to provide stability... The research team drilled the boreholes to depths ranging between 10 to 15 meters.)

Therefore, using the active or the passive voice is dependent on the subjects of your sentences. Choose your subjects to be:

1. Short (as explained above, avoid long subjects that are too far from their verbs)
2. Known information (as explained above, sentences should start with known information)
3. The main focus of the sentences (as explained above, the main idea of the sentence should be identified at the beginning of the sentence).

By choosing the proper subjects, you will be automatically using the proper voice in your sentences.
You are expected to write sentences that are:

This means they need to:

<table>
<thead>
<tr>
<th><strong>Simple</strong></th>
<th>Include only one main idea per sentence.</th>
<th>Consider the following sentences: Flooding is an extreme weather condition that has increased in frequency due to climate change, and through both direct and indirect means, the public’s safety is threatened as a direct cause of the rise in moisture content. Floodings is an extreme weather condition that has increased in frequency due to climate change. Beside their direct impacts on public safety, floods can also have indirect effects on public health. For instance, the resulting increase in the moisture content of indoor environments may lead to asthma. <em>(In the second example, different ideas are included in independent sentences, which makes the sentences easier to understand.)</em></th>
</tr>
</thead>
</table>

**Exceptions to using simple sentences:**
Two (or more) ideas can effectively be connected in a single, complex sentence when:
1. each idea is relatively simple, and
2. the relationship between the ideas is important and serves one of the following functions:

| Basis of information | Based on our initial observations, we conclude that... The technical team examined the design codes provided by the... |
| Method | In this experiment, the response of clay to various forces was measured using a rheometer. |
| Purpose | We monitored the water quality over a ten-year period to observe any changes in water composition. |
| Condition | If air quality monitors are misplaced, they can lead to inaccurate readings. |
| Specific detail | Over 100 buildings were offered water-damage treatments, including grey water treatments, black water treatments, and mold remediation. |
| Reason or cause | Porous pavements are commonly used in areas prone to flashfloods because of their ability to absorb large amounts of rainwater. |
| An evaluation or comparison | In 2017, the annual rainfall recorded at the station was 239 millimeters, which is 27% lower than the annual rainfall recorded in 2016. |
### Structure and organization: Paragraphs in technical writing

<table>
<thead>
<tr>
<th>You are expected to write paragraphs that are:</th>
<th>This means they need to:</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focused</td>
<td>Revolve around one theme <em>(In this example, the paragraph focuses on fine aggregate characteristics that can be determined by ASTM C1X5X)</em></td>
<td>(1) In this study, fine aggregate characteristics were evaluated according to ASTM C1X5X. (2) This standard lists three procedures (Methods A, B, and C) to measure the void content of fine aggregate. (3) While Methods A and C use graded fine aggregate (consisting of different sizes of aggregate), Method B uses several individual size fractions (each aggregate size is tested on its own for void content). (4) Depending on the method used, the measured void content may provide further indications of the aggregate’s characteristics. (5) For instance, using Method A to measure the void content of an aggregate of a known grading, the results can further indicate the aggregate’s angularity, sphericity, and surface texture. (6) On the other hand, when void content is measured on an as-received fine-aggregate grading (Method C), the results can predict the aggregate’s performance (workability) when used in the field. (7) Therefore, various tests should be conducted under various conditions.</td>
</tr>
<tr>
<td>Organized</td>
<td>Use transitions and connective devices between ideas <em>(Notice how the underlined transitions enhance the flow of ideas and help achieving the known-new contract in sentences)</em></td>
<td></td>
</tr>
<tr>
<td>Cohesive</td>
<td>Balance general statements with specific details <em>(General statements should provide the context and specific statements should provide details. For instance, sentence 2 provides a general statement about the various procedures listed in the standard. Then, sentence 3 provides specific comparisons between the three methods)</em></td>
<td></td>
</tr>
<tr>
<td>Balanced</td>
<td>Use different tenses when reporting different types of information <em>(Notice the change of tenses and verb types in this paragraph. Descriptions of the actual procedures conducted are reported in the past tense (were evaluated). However, the descriptions of the methods are reported using the present tense because they include general facts about those methods (lists, use, uses).) Also, when discussing possibilities and necessities, modal verbs are used (may, can, should)</em></td>
<td></td>
</tr>
</tbody>
</table>
## Structure and organization: Overall sections and subsections in technical reports

<table>
<thead>
<tr>
<th>Typical Report Structure</th>
<th>Section Description</th>
</tr>
</thead>
</table>
| **Abstract/Summary**     | • Identifies the problem/questions that the project addresses  
                          • States the objectives of the project  
                          • Describes the general procedures  
                          • Includes key results (quantitative results and key trends)  
                          • Evaluates results in light of the problem/questions  
                          • Lists the main conclusions  
                          • Suggests future work or implementation |
| **Introduction** (and Theoretical Background) | • Identifies the problem/questions that the project addresses  
                          • Describes related work done on the topic (previous work, theoretical background, key parameters, equations, etc.)  
                          • States the (specific and measurable) objectives of the current project  
                          • Lists the general procedures (including the measurements and calculations) that will be used to achieve the objectives |
| **Methods/Procedures**   | • Describes the scientific method/approach used to collect data  
                          • Describes the materials and equipment used to collect data  
                          • Describes the detailed procedures followed to collect data in a way that would allow someone else to reproduce such procedures  
                          • Describes the process by which measurements were recorded, preserved, and analyzed |
| **Results/Data/Findings (and Analysis)** | • Reports key results and explains their meaning  
                          • Explains data derivations and transformations obtained from the measured data  
                          • Presents key results visually (tables, figures, graphs)  
                          • Reports discrepancies and anomalies in the results |
| **Discussion**           | • Compares measured results to predicted values  
                          • Explains the discrepancies and anomalies in the results |
| **Conclusions and Recommendations** | • Summarizes the most important results reported in the report  
                          • Assesses the success of the project  
                          • Suggests possible future improvements (e.g. address error sources, safety issues, alternative approaches)  
                          • Ends with a bottom line statement (why should the reader care about the results?) |
| **Additional sections**  | • References (lists the external sources cited in the report)  
                          • Appendices (includes raw data, sample calculations, error analysis, etc.) |
## Structure and organization: Overall sections and subsections in research papers

<table>
<thead>
<tr>
<th>Typical Research Paper Structure</th>
<th>Section Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract/ Summary</strong></td>
<td>• Provides an overview of the paper: background, purpose, methods, findings, conclusions, value/implications</td>
</tr>
</tbody>
</table>
| **Introduction and Literature Review** | • Establishes the topic (narrows down the topic from general explanations to a specific angle/scope/problem)  
• Reviews the literature (reviews aspects of the problem that have been previously studied and organizes them thematically)  
• States the gap (identifies the need for further investigation/research with respect to a particular aspect of the problem)  
• States the purpose (explicitly states the purpose/ objective/ hypotheses of the study) |
| **Methods**                     | • Details the methods, materials, and procedures used in the study |
| **Results/ Findings**           | • Presents the findings by theme  
• Reports the data and interprets their meaning in light of the purpose of the paper |
| **Discussion**                  | • Expands on the major interpretations  
• Compares findings to the literature |
| **Conclusions**                 | • Presents the importance of the findings and how they may be applied in broader contexts (other contexts, disciplines, real-life scenarios, etc.)  
• Includes limitations and suggestions for future work |
| **Acknowledgements**            | • Gives thanks and credit to contributors other than the listed authors |
| **References**                  | • Documents the sources using an acceptable style |
4. The Form of Technical Writing

Developing your technical form
After revising and editing the content of your text, you should turn your attention into proofreading the appearance of your documents. Form pertains to the format (typography, layout, graphics, etc.) and mechanics (grammar, punctuation, spelling, etc.) of technical writing.

Formatting
Your documents should have an accessible form/design that is appealing to your readers. The following page layout settings make your text easy to follow:

- Use 12-point Times New Roman, double-space text, and 1" x 1" margins throughout.
- Include a title page and running heads.
- Number your pages.
- Include titles, headings, and subheadings that are parallel and hierarchical.
- Either have tabs at the beginning of paragraphs or spaces between paragraphs, not both.

Compact blocks of texts overwhelm readers and impede their abilities to process the information in your documents (see Figure 1). Therefore, when formatting your text, use highlighting techniques, such as:

1. **Boldface** *italics* and underlined text (do not highlight words by writing them with all capital letters)
2. White space
3. Parallel lists (either included in the running text or vertically using bullet points and numbers)
4. Graphics (table and figures)

Figure 1 The overall layout for research papers (A) and technical reports (B)
Using Graphics in technical documents

Graphics help enhance the form (appearance) of your technical documents in order to better communicate your messages to your readers. Graphics (e.g. tables, figures, and graphs) should be used to complement your text, especially when describing your data. Illustrations can help visualize, simplify, and clarify data findings. The list below includes some general guidelines relevant to the production and use of illustrations in technical documents.

A. Graphics should be used to simplify information

1. Graphics should tell a story about your data in a clear, concise, and uncluttered way. Avoid using complicated graphics that may confuse readers.

2. It is more effective to include your tables and figures after explaining them in your text. If you include the visuals before explaining them, your readers may become confused about what those visuals mean, and they will try to either: 1) read and understand those visuals by themselves, which may overwhelm them, or 2) scan your text for explanations, which may lead them to skip over important information.

B. Graphics should reinforce written text

1. Graphics should complement your text. Do not include a graph, table, or figure that you do not mention or explain in your running text. The written text should explain to the graphics, and the graphics should support the text. Include extra tables and figures in the Appendices.

2. Graphics should be used to support the written text, but they cannot replace it altogether. Do not just refer your reader to a graphic. If you cannot explain something in writing, the graphic won’t be able to either.

3. Keep in mind that different types of visuals present information in specific ways and for specific purposes. For instance, tables work better with quantitative/descriptive data, and graphs work better to show qualitative trends. You should not include the same data in more than one type of display (either a table or a graph). Pick the best format based on the type of your data.

C. Graphics should be ethical

1. Do not use graphics to hide, manipulate, or exaggerate information. Be honest to your readers.
2. Make sure to cite graphics obtained from secondary sources. In-text citations should be included in the caption and full citations should be included in the list of references. For example: Figure 5 Typical Gradation Curve for Sand (Source: Mehta and Monteiro, 2006).

3. If you modify any aspect of the visuals, include “Adapted from” in your in-text citations. For example: Figure 5 Typical Gradation Curve for Sand (Adapted from: Mehta and Monteiro, 2006).

D. Graphics should be labeled, formatted, and placed properly

1. Always number and include a title for your visuals (titles go above tables and below figures). Refer to your visuals by their specific numbers in your text (avoid phrasings such as the table below and the figure above—use their specific numbers to refer to them).

2. Because you need to include a title in the captions of your figures, the graph title inserted automatically by Excel is redundant. Remove it when importing your graphs into Word.

3. Tables should include headings and units for the values included in the rows and columns.

4. Axes on graphs should be labeled descriptively and should indicate the units. Axes should also have tic marks that are reasonably spaced, and the last tic mark should be at the end of the axis. Space on graphs should be used efficiently, and wasted space should be avoided.

5. The number labels on the axes should be large enough to read. You may need to change the default settings on Excel and check if those settings change once importing your graphs into Word documents.

6. Define all the markers and trend lines on your graphs through a clear legend.

7. When possible, remove the gridlines on your graphs to achieve a clearer display.

8. Colorful backgrounds on displays look nice on screens, but technical information tends to be lost when the figure is printed in black and white. Use a white background for all graphs.

9. It is not always easy to distinguish among the default colors and symbols when the graphs are printed in black and white. Selecting open and filled markers is one way to distinguish one data set from another. Different line types may also be used.

10. Make sure that your visuals, especially tables, are not broken across multiple pages. Also, modify the default settings on Word to create engaging and easy-to-read tables.
Figures 2 and 3 below display some of the above guidelines. Notice how the suggested guidelines can improve the clarity and efficiency of graphs and tables in technical documents. For further information on the use of visuals in technical documents, refer to the APA Guidelines.

The purpose of this experiment is to observe the effect of Reynolds number on the theoretical and experimental Nusselt numbers. Figure 1 shows that a direct correlation exists between Reynolds number and the theoretical and experimental Nusselt Numbers ($R^2 = 0.993$ and $0.997$ respectively).

Figure 1. Varying Nusselt Number (Theoretical and Experimental) as a function of Reynolds Number.

Figure 2 Graphical representation of data
Mechanical errors can also reflect badly on you as a credible writer and engineer. Writing mechanics reflect the writer’s thoroughness and accuracy. Mechanical errors are especially detrimental when they lead to ambiguous words and sentences, thus resulting in impeding the understanding of the readers. In this section, you will find a list of some common mechanical errors in technical writing. Use this list when proofreading your own technical documents.
<table>
<thead>
<tr>
<th>Common mechanical errors:</th>
<th>This means:</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comma splices</strong></td>
<td>Two sentences are joined with a comma instead of conjunctions (and, but, or, etc.)</td>
<td>Incorrect: The amplifier was used to increase the intensity of the sound signals, noise in the room became unbearable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Correct: The amplifier was used to increase the intensity of the sound signals; noise in the room became unbearable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The amplifier was used to increase the intensity of the sound signals, but noise in the room became unbearable.</td>
</tr>
<tr>
<td><strong>Fused sentences</strong></td>
<td>Two sentences are joined without punctuation</td>
<td>Incorrect: Please come to my office I need to talk to you.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Correct: Please come to my office. I need to talk to you.</td>
</tr>
<tr>
<td><strong>Punctuating citations</strong></td>
<td>Punctuations are placed after, not before, in-text citations</td>
<td>Incorrect: Indoor air pollution is strongly correlated to cardiovascular diseases. (Smith, 2009)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Correct: Indoor air pollution is strongly correlated to cardiovascular diseases (Smith, 2009).</td>
</tr>
<tr>
<td><strong>Misplaced modifiers</strong></td>
<td>Keep modifiers close to the words that they modify</td>
<td>Incorrect: The device consists of a screw that is inside a barrel that is driven by an electric motor drive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Correct: The device consists of a barrel with an enclosed screw that is driven by an electric motor drive.</td>
</tr>
<tr>
<td><strong>Parallel structure</strong></td>
<td>Use similar forms of words/ terms for similar ideas (e.g. in a list)</td>
<td>Incorrect: The sensor responds to various stimuli, including sound, heat, and vibrating objects that may cause disturbances.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Correct: The sensor responds to various stimuli, including sound, heat, and vibrations.</td>
</tr>
<tr>
<td>Common mechanical errors:</td>
<td>This means:</td>
<td>Examples</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td><strong>Subject-verb agreement</strong></td>
<td>Verbs must agree with their subjects</td>
<td>Incorrect: The <em>radiometer</em>, along with the receiver, <em>were</em> placed on the lab bench.</td>
</tr>
</tbody>
</table>
| **Pronoun agreement** | Pronouns must agree with their antecedent nouns | Incorrect: Everyone on the research team had to receive their training certificates. | Correct: Everyone on the research team had to receive his or her training certificates.  
All members had to receive their training certificates. |
| **Commonly misused words** | Some words are mistakenly used interchangeably | Comprise/Compose  
Comprise: to embrace or include  
Compose: made up of, constituted of | Affect/Effect:  
Affect: verb (except in psychology)  
Effect: noun (except when used to mean “bring about”)  
Continual/continuous:  
Continual: repeatedly  
Continuous: without interruption  
Its/’its’:  
Its: possessive (“of it”)  
’Its’: contraction (“it is”)  
Like/as:  
Like: preposition  
As: conjunction  
Principle/principal:  
Principal: most important (adj.), most important person (n)  
Principle: law |
<table>
<thead>
<tr>
<th>Common mechanical errors:</th>
<th>This means:</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Unnecessary hyphenation   | Use hyphens when two or more words modify another word, and work together as a unit. | Acetic-acid water system  
Liquid-gas interface  
A 20-percent increase  
A two- or three-week incubation period |
|                           | Do not hyphenate most prefixes added to common nouns. | precooled not pre-cooled  
nonpolar not non-polar |
| When to spell out numbers | Spell out numbers less than 10 and at the beginning of sentences. | Forty-seven percent of the sample evaporated.  
The experiment evaporated 47% of the sample.  
The experiment included eight samples. |
|                           | Spell out the unit of measurement when no quantity is included | Several milligrams, not several mg |
|                           | Do not use plurals for abbreviated units of measurement | 60 mg, not 60 mgs |
| Using units of measurement | In ranges and series, retain only the first unit of measurement | 10-12 mg, between 24 and 50 ml |
|                           | When a sentence starts with a specific quantity, spell it out along with its unit of measurement | Twenty-five milligrams of acetone were added.  
Thirty-seven percent of the sample was dissolved |
|                           | Use the percent symbol with a numeral form, without a space | 30%  
65-70% |
| When to capitalize        | Numbered items (figures, tables, etc.) should be capitalized when referred to in the text. Write the numbers in numeral form. | As shown in Figure 1  
See Table 2  
As given in Equation (3) |
|                           | Non-numbered items are not capitalized. | As shown in the figures |
|                           | When referring to formulas, equations, and other items with someone’s name, capitalize only the name of the author (not the noun). | Avogadro’s number  
Newton’s first law |
5. Concluding Remarks

Technical writing is a process that requires multiple rounds of writing and rewriting. The resulting writing outcome will be assessed in terms of its: content, style and structure, and form. Technical courses at MSFEA will likely be more invested in the comprehensiveness and accuracy of your content rather than in minor grammatical errors. For instance, missing a comma (a grammatical form error) will clearly have a minor effect on your technical audience compared to a technical idea that is phrased ambiguously (a stylistic error), or a missing technical definition or explanation (a content-related error). Needless to say, style and form errors become more pronounced once they impede the clarity and understandability of the technical content.

The set of guidelines listed in this document is meant to explain how writing is intertwined with several core tasks in engineering such as research, analysis, problem-solving, and decision-making. Think of writing as a process that complements the development of technical knowledge and your ability to express such knowledge. Writing is just another strategic task that you will conduct as an engineer.

6. Bibliography

The following books and resources provide more information on the topics covered in this document: