# Prompt Engineering Guide for Engineering Students

## Introduction

This guide will help you develop effective prompts for AI tools like ChatGPT, Claude, or GitHub Copilot in your engineering coursework. Learning to communicate effectively with AI tools is becoming an essential skill for engineers. This guide covers basic principles, strategies for engineering-specific tasks, and examples tailored to common engineering scenarios.

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 ## 1. Prompt Engineering Fundamentals

### The Basics of Effective Prompts

Effective prompts are: - **Clear**: State exactly what you need - **Specific**: Provide relevant context and constraints - **Structured**: Organize complex requests logically - **Iterative**: Refine based on initial responses

### General Prompt Structure

A well-structured prompt typically includes:

1. Context: Who you are and your background knowledge
2. Task: What you want the AI to do
3. Format: How you want the information presented
4. Constraints: Any limitations or requirements
5. Example: If helpful, a sample of desired output

### Example of Basic vs. Enhanced Prompts

**Basic Prompt:**

How do I calculate stress in a beam?

**Enhanced Prompt:**

I'm a second-year mechanical engineering student learning about beam analysis.
Please explain how to calculate bending stress in a simply-supported beam with
a point load at the center. Include the relevant equations, a step-by-step
calculation example with a steel I-beam, and note any assumptions being made.
Please format your response with clear section headings and include a simple
diagram I could sketch in my notes.

 ## 2. Engineering-Specific Strategies

### Providing Technical Context

Always specify: - Your engineering discipline/subdiscipline - Your knowledge level - Relevant coursework you’ve completed - Software/tools you’re using - Standards or codes you’re following

### Requesting Mathematical Content

For equations and calculations: - Request step-by-step solutions - Ask for explanations of variables and units - Specify notation conventions (if important) - Request verification of units and dimensional consistency - Ask for order-of-magnitude checks when appropriate

### Requesting Code

For programming help: - Specify the programming language and version - Mention libraries or frameworks you’re using - Provide sample input/output if applicable - Request comments explaining the engineering principles - Specify code style preferences (if relevant)

### Physical System Descriptions

When describing engineering systems: - Define boundary conditions clearly - Specify all relevant properties (materials, dimensions, etc.) - Note any idealizations or simplifications - Include environmental conditions if relevant - Indicate precision requirements

 ## 3. Example Prompts by Task

### Concept Explanation

**Task:** Getting a clear explanation of a difficult concept

**Effective Prompt:**

I'm studying electrical engineering and struggling with understanding the
physical meaning of Laplace transforms in circuit analysis. I understand basic
differential equations and circuit theory.

Please explain:
1. The physical interpretation of what a Laplace transform means in circuit analysis
2. Why it's useful compared to time-domain analysis
3. A simple example applying it to an RLC circuit
4. Common conceptual mistakes students make

Include analogies that would help me visualize what's happening.

### Problem-Solving Assistance

**Task:** Getting help with a challenging problem

**Effective Prompt:**

I'm solving a fluid mechanics problem about pipe flow and want to check my
approach. I'm a 3rd-year civil engineering student.

Problem: Water flows through a 10cm diameter pipe at 2 m/s. The pipe reduces
to 5cm diameter. The pipe is horizontal and we can assume negligible friction.

My approach:
1. Use continuity equation to find velocity in the smaller section
2. Apply Bernoulli's equation between the two sections
3. Calculate pressure difference

Can you verify if my approach is correct? If so, please walk through the solution
step-by-step. If not, please explain what I'm missing. Include the engineering
principles behind each step.

### Design Guidance

**Task:** Getting design suggestions

**Effective Prompt:**

I'm working on a senior design project to create a solar-powered water
purification system for remote areas. We need to:
- Process 1000 liters/day
- Use only solar power (no grid connection)
- Design for a tropical climate
- Keep manufacturing costs under $500
- Use locally available materials where possible

Please suggest:
1. 3-4 potential system architectures
2. Key design considerations for each
3. Preliminary component sizing approach
4. Potential failure modes to consider
5. Sustainability considerations

Format as a structured design brief with sections for each component of the system.

### Code Debugging

**Task:** Debugging engineering calculation code

**Effective Prompt:**

I'm trying to debug this MATLAB code that calculates beam deflection using
numerical methods. The code runs but gives unreasonable values (deflections in
kilometers rather than millimeters). I suspect there's a units problem or a
fundamental error in my approach. Here's my code:

[paste your code here]

My inputs are:
- Length: 2 meters
- Applied force: 1000 N
- Young's modulus: 200 GPa
- Moment of inertia: 5×10^-6 m^4

Please:
1. Identify any errors in my implementation
2. Explain why these errors would cause such extreme results
3. Provide corrected code with explanations
4. Suggest a simple test case to verify the solution

### Literature Review Help

**Task:** Synthesizing technical literature

**Effective Prompt:**

I'm a graduate student beginning research on carbon fiber composites for
aerospace applications. I need help organizing my initial literature review.

Please provide:
1. A suggested structure for my literature review
2. 5-7 key subtopics I should cover
3. The fundamental papers or researchers I should be familiar with
4. 3-4 current research trends in this field
5. Suggested search terms for finding relevant papers

My background is in mechanical engineering with basic knowledge of materials science.

 ## 4. Troubleshooting Poor Results

### Common Issues and Solutions

| Problem | Possible Solutions |
| --- | --- |
| Too basic or general responses | Add your educational level, specify prior knowledge, request advanced treatment |
| Incorrect technical information | Ask AI to cite sources, verify against textbooks, request alternative approaches |
| Unclear explanations | Request specific examples, ask for analogies, request step-by-step breakdowns |
| Too much information | Specify word/length limits, request focused response on specific aspects |
| Too little detail | Break complex questions into parts, request elaboration on specific points |

### Refining Your Prompts

If you receive an unhelpful response, try these refinement strategies:

1. **Specify Knowledge Level**: “Please explain this at the level of a 3rd-year engineering student who has completed courses in X, Y, and Z.”
2. **Request Alternative Approaches**: “Can you explain this using a different approach or analogy that might be clearer?”
3. **Break Down Complex Questions**: “Let’s focus just on part X first, then we’ll move to Y.”
4. **Request Verification**: “Can you verify these calculations and confirm the units are consistent throughout?”
5. **Ask for Clarification**: “I don’t understand the explanation of X. Can you explain that differently with a concrete example?”

 ## 5. Ethical Considerations

### Academic Integrity

Always: - Follow your instructor’s guidelines for AI use - Document your use of AI tools when required - Understand the solutions provided, don’t just copy them - Use AI as a learning tool, not a substitute for learning

### Critical Evaluation

Remember that AI tools: - May provide incorrect or outdated information - Don’t have the judgment of experienced engineers - Cannot verify safety considerations - Have no professional liability for errors - Work from limited datasets that may contain biases

### Responsible Use Tips

1. **Verify Critical Information**: Always double-check safety-critical calculations or advice
2. **Understand Limitations**: Be aware of what the AI cannot do (e.g., access current data, perform original research)
3. **Maintain Skills**: Continue developing fundamental skills even when using AI assistance
4. **Credit Appropriately**: When submitting work that used AI assistance, document this appropriately according to course policies
5. **Learn Actively**: Use AI to enhance your understanding, not replace it

## Conclusion

Effective prompt engineering is a skill that requires practice. Start with basic prompts, then refine them as you learn what works best for different tasks. Remember that AI tools are assistants to augment your engineering skills and knowledge, not replace them.

As you use these tools, maintain your critical thinking skills and engineering judgment. The most effective use of AI comes from combining its capabilities with your unique human creativity, contextual understanding, and professional responsibility.

*This guide was developed as part of the “Strategies for Integrating Generative AI in Engineering Education” initiative in collaboration with Claude-3.7 Sonnet. It is intended to be adapted by instructors for specific course contexts.*