1.1 Problem Statement

Problem: Qubits (quantum representations of classical bits) are necessary for Quantum computing, Quantum Networks, and more, and improvements to efficiency and performance are necessary to develop better systems. Current systems require extremely low temperatures (T<1°K) to operate, and the coherence time (the amount of time a qubit state can exist before degrading) is very low for classic materials. Improvements in operating temperature and coherence times are necessary for the future of quantum systems.

Proposed solution: Research existing and emerging materials to create simulations of qubits created by rare-earth doped crystals. Rare earth materials have much longer coherence times (~1-4ms) and can exist at higher temperatures (1<T°K<3) than existing qubit structures, and have intrinsic "shielding" effects which prevent external stimuli from disrupting the qubit. Due to other material properties they are also much more scalable for larger and more powerful systems.

1.2 Requirements & Constraints

List all requirements for your project . This includes functional requirements (specification), resource requirements, qualitative aesthetics requirements, economic/market requirements, environmental requirements, UI requirements, performance requirements, legal requirements, maintainability requirements, testing requirements and any others relevant to your project. When a requirement is also a quantitative constraint, either separate it into a list of constraints, or annotate at the end of requirement as "**(constraint)**". Other requirements can be a single list or can be broken out into multiple lists based on the category.

Our component must be an accurate representation of Qubit. This means it is capable of representing values from 0 to 1. This will be represented by the electron spin of the Rare earth metals in our compound.

The method necessitates the use of Rare Earth metals, this being Lanthanides, Yttrium, and Scandium. These elements have properties that are necessary for the performance of our project.

Because of resource limitations, we will only be able to test compounds in simulation. The timeframe required to actually create these compounds is simply too long for this course to encompass.

1.3 Engineering Standards

What Engineering standards are likely to apply to your project? Some standards might be built into your requirements (Use 802.11 ac wifi standard) and many others might fall out of design. For each standard listed, also provide a brief justification.]

IEEE P2995: Trial-Use Standard for Quantum Algorithm Design and Development:

- **This trial-use standard defines a standardized method for the design of quantum algorithms. The defined methods apply to any type of algorithm that can be assimilated into quantum primitives and/or quantum applications. The design of the algorithms is done preceding quantum programming.**

IEEE P7130 Standard for Quantum Technologies Definitions:

- **This standard addresses quantum technologies-specific terminology and establishes definitions necessary to facilitate clarity of understanding to enable compatibility and interoperability.**

Due to Quantum computing being a relatively new field with few industry applications at this time, the active standards related to this field are not fully developed and are more or less proposed by researchers studying the topic.

1.4 Intended Users and Uses

Who benefits from the results of your project? Who cares that it exists? How will they use it? Enumerating as many "use cases" as possible also helps you make sure that your requirements are complete (each use case may give rise to its own set of requirements).

The main group of people who will benefit from the results of this project include workers studying in the field of quantum computing and quantum technologies, such as:

- **Researchers and Scientists**
- **Hardware/Software Developers**
- **Government and Defense Agencies.**

The qubits are useful for their ability to do parallel computation, and their theoretical properties for communication systems.