Vector Assignment 1

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1. Define what a vector is in your own words. Provide an example of a vector and explain how it's different from a scalar number. A vector is a mathematical quantity that has both magnitude and direction. example:

Vector has both magnitude and direction like velocity, force, or displacement, while the Scalar quantity has only magnitude, for example, temperature, mass, or speed are scalar quantities because they are described solely by their numerical value without indicating any specific direction.

2. Give three real-world examples of where vectors are used. Robotics and Motion Planning: In robotics, vectors are used to represent the positions and orientations of robots and objects in a workspace. Robot motion planning involves calculating paths and trajectories using vectors to ensure efficient and collision-free movement. Vectors are also used to represent forces and torques applied by robotic arms and grippers, aiding in tasks like assembly and manipulation.

Financial Portfolio Management: In finance, vectors are employed to represent the returns of various assets within a portfolio. Each asset's return over a period can be represented as a vector component, and the entire portfolio's performance can be understood through vector operations such as addition, subtraction, and scalar multiplication. Modern portfolio theory uses vectors to optimize asset allocations based on risk and return objectives.

Aircraft Navigation:

Vectors play a crucial role in aircraft navigation systems. Flight paths, wind directions, velocities, and positions are all represented using vectors. For instance, the velocity vector of an aircraft combines the speed (magnitude) with the direction of travel, allowing pilots and air traffic controllers to manage flight paths, fuel consumption, and safety measures efficiently.

3. Explain the concept of a basis in vector spaces. What properties must a set of vectors have to be considered a basis?

4. Consider the vector space $R\hat{2}$ (2D plane). Give an example of a basis for this space and explain why it forms a basis.