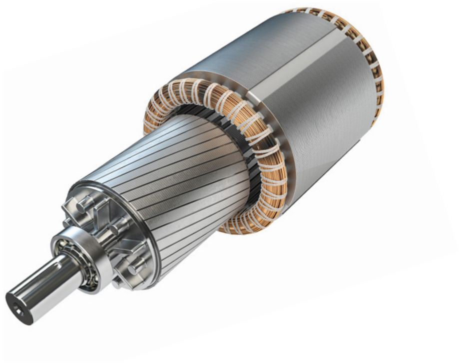
Understanding How Vibration Changes with Rotor Speed

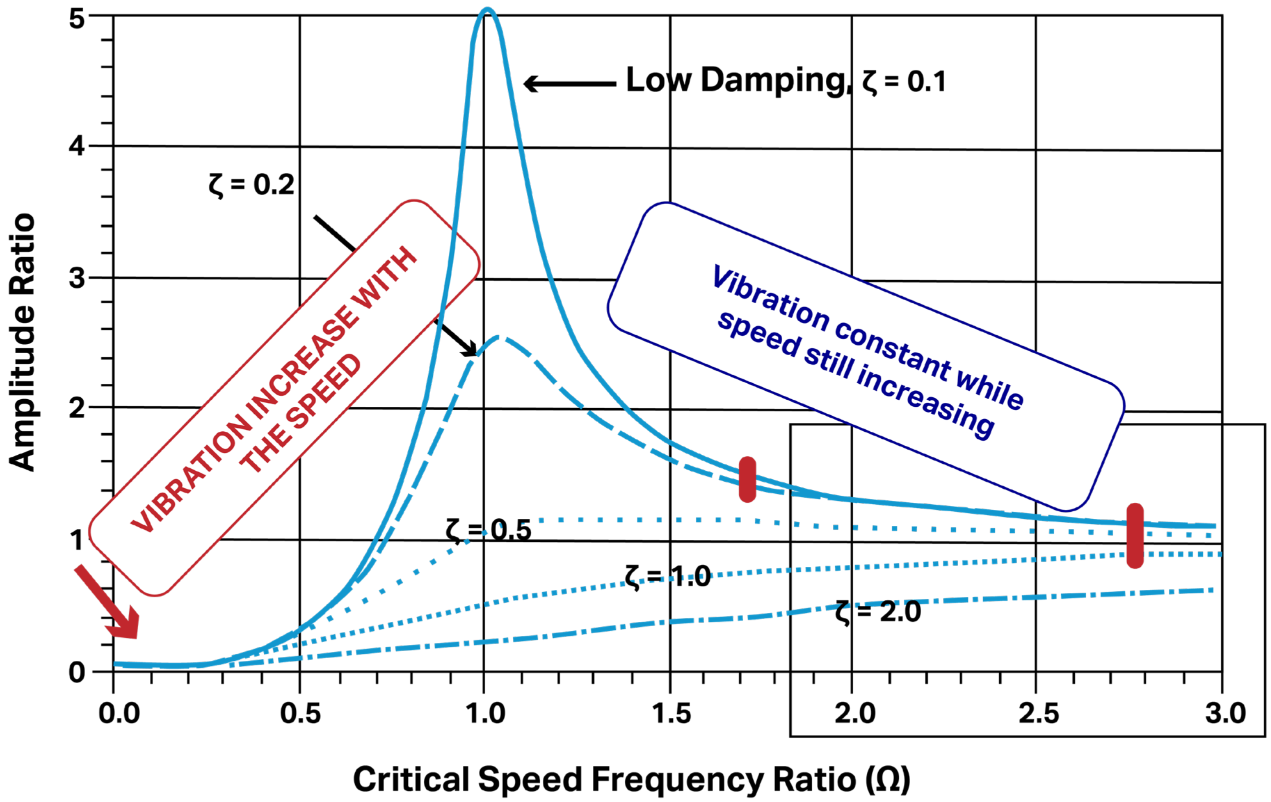
In the study of **rotordynamics**, understanding how vibration changes with rotor speed is crucial for the design and maintenance of rotating machinery.



When the rotor operates below its first critical speed, vibration increases proportionally to the square of the speed. This relationship, however, undergoes a significant shift as the rotor speed surpasses the first critical speed. At higher speeds, vibrations can stabilize or even decrease, with the shaft beginning to rotate around its center of mass.

This counterintuitive behavior is explained by **Jeffcott rotor theory**, which reveals that beyond the first critical speed, the rotor's natural frequencies align with the excitation frequency induced by rotation. This alignment creates a balancing effect where the centrifugal forces on the rotor counteract the elastic forces within the shaft, leading to reduced vibration amplitudes. Essentially, the system reaches a state of dynamic equilibrium characterized by stable whirl orbits and a balance between centrifugal and elastic forces.

As rotor speed continues to increase, this dynamic equilibrium along with factors such as whirl motion, self-damping, and frequency locking, helps to stabilize vibration levels, preventing the expected rise in vibration. This phenomenon is critical for engineers to understand, as it influences the operational limits and maintenance strategies for high-speed rotating machinery.



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Bode Plot