Abstract

The influence of external and internal damping with gyroscopic forces on the Sommerfeld effect in eccentric rotor dynamic systems driven by limited power DC motor (*i.e.*, a non-ideal source) is studied in this thesis. Contrary to the common belief that the rotating internal damping has no influence on the synchronous whirl and thus on the passage through resonance, it is shown that it indeed influences the thresholds of power input to the motor at which the characteristic jumps in the rotor speed and vibration amplitudes associated with the Sommerfeld effect take place. It has been further shown that the stability threshold may restrict the jump phenomena due to the Sommerfeld effect for larger values of internal damping. Moreover, the Sommerfeld effect may altogether cease to exist at certain critical speeds for higher values of external damping.

The characteristics of the Sommerfeld effect induced jump phenomena has been studied for the considered rotationally symmetric systems through instantaneous power balance which have been obtained from the bond graph models explicitly portraying the drive-structure interactions. The bond graph models have been used for numerical simulations to validate the theoretical results.

Two kinds of rotor dynamic systems, namely, an eccentric discrete rotor and a rotating flexible shaft, are studied separately. For the later system, the motor speed has to pass through several critical speeds before reaching the stability threshold speed. Besides, it has been shown that the higher modes of that infinite dimensional system may become unstable before lower ones depending on the values of the external and internal damping. The Sommerfeld effect in these rotor dynamic systems has been studied at the stability threshold and during passage through resonances.

***Keywords**:* non-ideal source, Sommerfeld effect, jump phenomena, rotor dynamics, rotating material/internal damping, circulatory forces, stability threshold, bond graph.