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# A General Formulation for N-Body Tethered Satellite System Dynamics

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General three-dimensional motion of tethered N-body systems is considered. Equations of motion are derived using the Lagrangian formulation. The derived equations are valid for large librational motion, variable lengths and an arbitrary orbit. The elasticity and mass of the tethers are taken into account. The longitudinal and transverse displacements of the tethers are assumed to be small compared to the lengths and are disceritized using *the assumed-mode method.* The nonlinear equations of motion are used for simulation of the system dynamics. However, for eigenvalue analysis and control applications the equations need to be linearized; this is done analytically. Several examples are considered. Librational as well as longitudinal and transverse elastic frequencies of several multi-body systems are obtained. A *semi-bead model* is used to obtain the higher frequencies of a system. It is observed that the librational, and transverse elastic frequencies of in-plane and out-of-plane motions are related by $(\omega_O/\Omega_c)_j^2 \approx (\omega_I/\Omega_c)_j^2 + 1$. Typical transient responses of three-body and four-body tethered systems are obtained.

## INTRODUCTION

Tethered satellite systems(**TSS**) have received a lot of attention in recent years. There have been many investigations on their dynamics and control [1]. Since initially

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