# סמינריון

הנך מוזמן/ת להרצאה סמינריונית של הפקולטה להנדסת מכונות שתתקיים ביום ד׳ 06.04.2022
(ה׳ בניסן, התשפ״ב), בשעה 13:00 **באופן היברידי:** אוד׳ 1, בניין דן קהאן וכן באמצעות ZOOM :
https://technion.zoom.us/j/94041065691?pwd=Mk1qb0RrRWxKd09vbWY5WmNJQUYrUT09

**מרצה**: גלעד בן צבי

**מנחה**: פרופ׳ח יזהר אור

**על הנושא:**

## Dynamics and stability of Purcell's micro swimmer model with flexible joints and/or controlled torque at the joints

The seminar will be given in Hebrew

**תקציר ההרצאה :**


Recently, there is a growing interest in miniature swimming robots inspired by biological swimming micro-organisms. These swimmers, due to their small dimensions, are governed by low Reynold number hydrodynamics where viscous drag forces are dominating while inertial effects are negligible. A simple classic model of micro-swimmer proposed by Purcell (1977) is a robot with three rigid links connected by two joints whose angles are prescribed periodically. In order to account for the effect of passive elasticity, inspired by flexible-tailed microorganisms, a similar swimmer model with one joint actuated by periodically oscillating angle and a second passive joint with a torsion spring was recently studied. Unlike this case of direct kinematic control of joint angle, in a more realistic situation the controlled input is the torque at the joint, that can be dictated either in open loop or by a feedback law based on the measured joint angle. Thus, the purpose of this study is to investigate the dynamic behavior of Purcell's swimmer model actuated by a single periodic torque combined with torsion springs at the joints. A dynamic nonlinear time-periodic system is formulated, in which both joint angles are evolving dynamically. The system has periodic solutions that are symmetric with respect to straightened configuration, in which the net motion is along a straight line with zero net rotation, as well as asymmetric periodic solutions where the joint angles oscillate about nonzero values and the swimmer's net motion is along an arc. The periodic solutions may be stable or unstable under small perturbations, and stability is determined by linearization of the system's Poincaré map. We present numerical analysis of existence, stability, and characteristics of symmetric and asymmetric periodic solutions, depending on model parameters – frequency and amplitude of the actuation and stiffness ratio of the joints. We show bifurcation points where the number of solutions changes and stability transitions occur. Limit cases with extreme parameter values are studied as well. The results of our analysis are important for understanding how the choice of actuated input and passive elasticity influence the dynamic behavior of micro swimmers, both in nature and in future optimal design of microbots.


בברכה,

*פרופ״ח מתי סאס*
מרכז הסמינרים