UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE of ENGINEERING

UNC Charlotte – Lee College of Engineering Senior Design Program
Company Information

Company Name	MEES -CPM	**Date Submitted**	*4/20/2021*
Project Title	Magnetorheological linear motor **(UNCC_ME_MAGNET)**	**Planned Starting Semester**	Fall 21

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	**Number**	**Discipline**	**Number**
Mechanical	2	Electrical	1
Computer		Systems	
Other ( )			

Project Overview and Requirements:

Methods used to drive motion control stages include fluid power pistons, feedscrews, and linear motors. These provide the force to drive a platform that is typically guided by rolling element or oil (or air) hydrostatic bearings. For precise motion control applications feedscrews and piston devices have now been abandoned because their inherently 'noisy' motion between the moving parts of the drive will be transmitted into motion of the stage.

Because there is no direct mechanical link between the magnet array and the force producing coils, linear motors are now ubiquitously used for driving hydrostatic bearings stages in precision machines. However, one major problem with these drives in their limited force and the fact that holding a force requires a constant current that, in turn, creates a significant heat source.

The drive mechanism considered here comprises a rigid link immersed in a magnetorheological fluid (MRF) with one end of the link attach to the moving stage. This link has small coils at each end and a piezoelectric actuator as its core. When energized, the magnetic field generated by the coils will solidify the MRF thereby creating a rigid connection to the base of the stage. If the coil at the free end of the stage is energized, the link is rigidly held at the base and the piezoelectric

element can then be used to move the stage. When the piezoelectric actuator gets to the end of its range, the other coil can be energized to lock the stage position while the other coil releases its 'grip' allowing the piezoelectric actuator to recover to its midpoint value. Hence this device can move the guided stage in a manor akin to the motion of an inchworm over unlimited distances.

Requirements:

The goal of this two-semester project is to design and test a linear drive mechanism based on magnetorheological clamps (clutches) and a piezoelectric actuator. Such an actuator, if it can be made to work, has the advantage of only a single moving part, nanometer level control, and it self-aligns to the guideway that it is driving.

The tasks of this project are the design and implementation of the drive and its coupling to a linear air bearing. Once up an running the experimental program will seek to demonstrate linear motions of up to 50 mm and control to within one micrometer.

All components for this design (air-bearing, current drive, MR fluid, capacitance displacement gage, piezoelectric actuators and drivers) are available in the Instrumentation Group laboratories and other items of construction will be supplied. Control will use NI myRIO within the Labview IDE.

Expected Deliverables/Results:

Deliverables include:

- Design and build of a demonstration platform.
- Theoretical model for predicting load capacity and dynamic performance.
- Technical report and user manual for future development of this system.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Ability to acquire a Green Badge for ME machine shop
- Basic understanding of electrical system and simple hardware computing