

(—; 3-0-1)

## Lagrangian Mechanics, Dynamics, and Control

MATH-439\*

This course covers advanced topics in dynamics and control, and is taken by Mathematics and Engineering students in their fourth year. Students can expect to apply new mathematical ideas to sophisticated engineering problems.

**Textbook:** *Geometric Control of Mechanical Systems*  
by F. Bullo and A. D. Lewis (Springer-Verlag)

**Prerequisite:** MATH-280\*, 281\*, 237\*, or 231\* or permission of the instructor.

**Instructor:** D. R. Tyner

**Evaluation:** Assignments            50%  
                  Final Examination    50%

### Outline:

1. Manifolds, maps between manifolds, generalized coordinates, and submanifolds
2. Configuration manifolds, modelling of free and interconnected rigid bodies
3. Tangent bundles and vector fields
4. Tensor fields and bilinear maps
5. Angular momentum, Riemannian metrics, the kinetic energy and generalized inertia tensor of a rigid body
6. The Euler-Lagrange equations, affine connections, and geodesics
7. External forces and potential energy
8. Simple mechanical systems and mechanical control systems equivalent to kinematic systems
9. Path planning, trajectory generation, and nonlinear control by kinematic controllability