Applied Mathematics in Robotics

Ragesh Kumar Ramachandran

Summer, 2019

E-mail: rageshku@usc.edu
Office: RTH 426

Class Hours: Thursday 3:30-5:00pm
Class Room: OHE 136

Course Description

This is a seminar course aimed at introducing abstract mathematical concepts which are widely used in robotics. The goal of this seminar course is to provide an intuitive understanding of various abstract mathematical concepts commonly used in robotics without diving deep into the technical details associated with them. Also, various robotics applications of the concepts will be discussed throughout the course. The course will primarily focus on the following topics:

- Basic real analysis
- Coordinate free linear algebra
- Dynamical systems
- Optimization/Optimal control
- Topology
- Differential geometry.

The ultimate goal of this seminar course is to provide a pictorial idea of the above mathematical concepts. The seminars should help the attendees to understand areas of robotics literature which exploits these mathematical frameworks.

Prerequisites

There are no prerequisite requirements for this course. But a good intuitive understanding of calculus, linear algebra, and differential equations are recommended.

Schedule

The schedule is tentative and can be changed according to the convenience of the attendees.

Week 01, 06/10 - 06/14: Basic real analysis

- Why analysis?
- Sequences
- Continuity and compactness
- Integration

Week 02, 06/17 - 06/21: Coordinate free linear algebra

- Abstract algebra
- Vector space
- Vectors and dual vectors

Week 03, 06/24 - 06/28: Dynamical systems I

- Linear systems
- Controllability
- Observability

Week 04, 07/01 - 07/05: Dynamical systems II

- Non linear systems
- Existence and uniqueness of solutions
- Stability

Week 05, 07/08 - 07/12: Optimization/Optimal control

- Lagrange multipliers
- Pontryagin maximum/minimum principle
- Dynamic programming

Week 06, 07/15 - 07/19: Differential geometry I

- Manifolds
- Vector fields
- Geodesics

Week 07, 07/22 - 07/26: Differential geometry II

- Lie groups

Week 08, 07/29 - 08/02: Topology

- Point set topology
- Homotopy
- Homology